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MONTHLY



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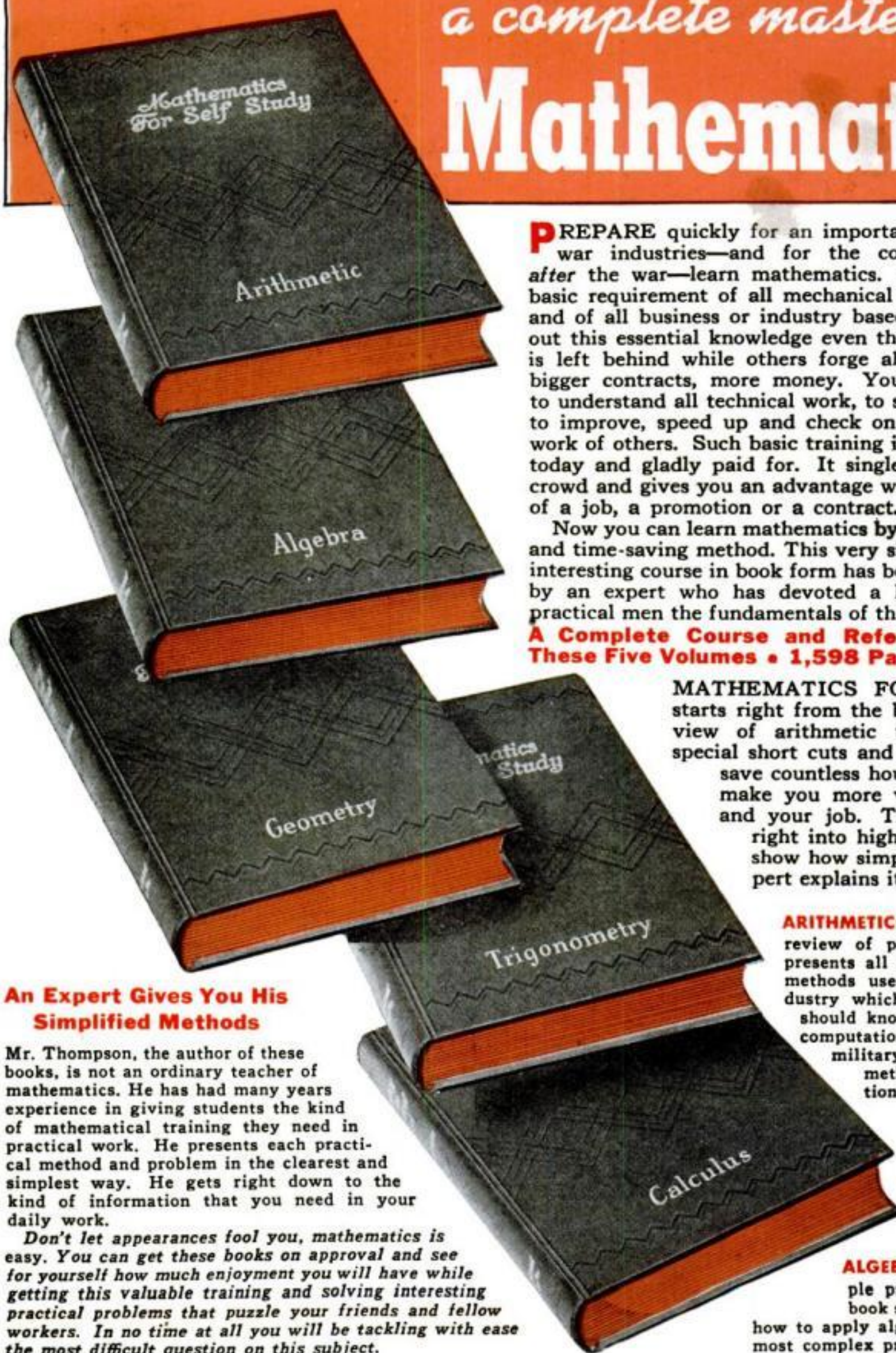
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A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

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ALLEN RAYMOND ("V-Foods vs. U-Boats," page 109) is a veteran war correspondent who has seen with his own eyes many of the earth-shaking events of recent years. From Rome, where he reported Italy's "stab in the back," to the Dutch East Indies, where he saw the Jap hordes sweep down from the north, he has followed the spread of war around the globe.

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Published monthly at 353 Fourth Avenue, New York 10, N. Y., by Popular Science Publishing Co., Inc. Godfrey Hammond, President and Treasurer; R. C. Wilson, Raymond J. Brown, Charles McLendon, Stephen P. Glennon, Vice-Presidents; F. W. Briggs, Secretary. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Entered as second-class matter at the Post Office Department, Canada. Printed in U.S.A. Copyright, 1943, by Popular Science Publishing Co., Inc. All rights reserved in the United States, Great Britain, and in all countries participating in the International Copyright Convention and the Pan American Copyright Convention. Yearly subscriptions to United States and its possessions, \$2.00; Canada, \$2.50; foreign countries, excepting Canada, \$3.00. Subscribers must notify us of change of address four weeks in advance of the next publication date. Be sure to give both old and new address.

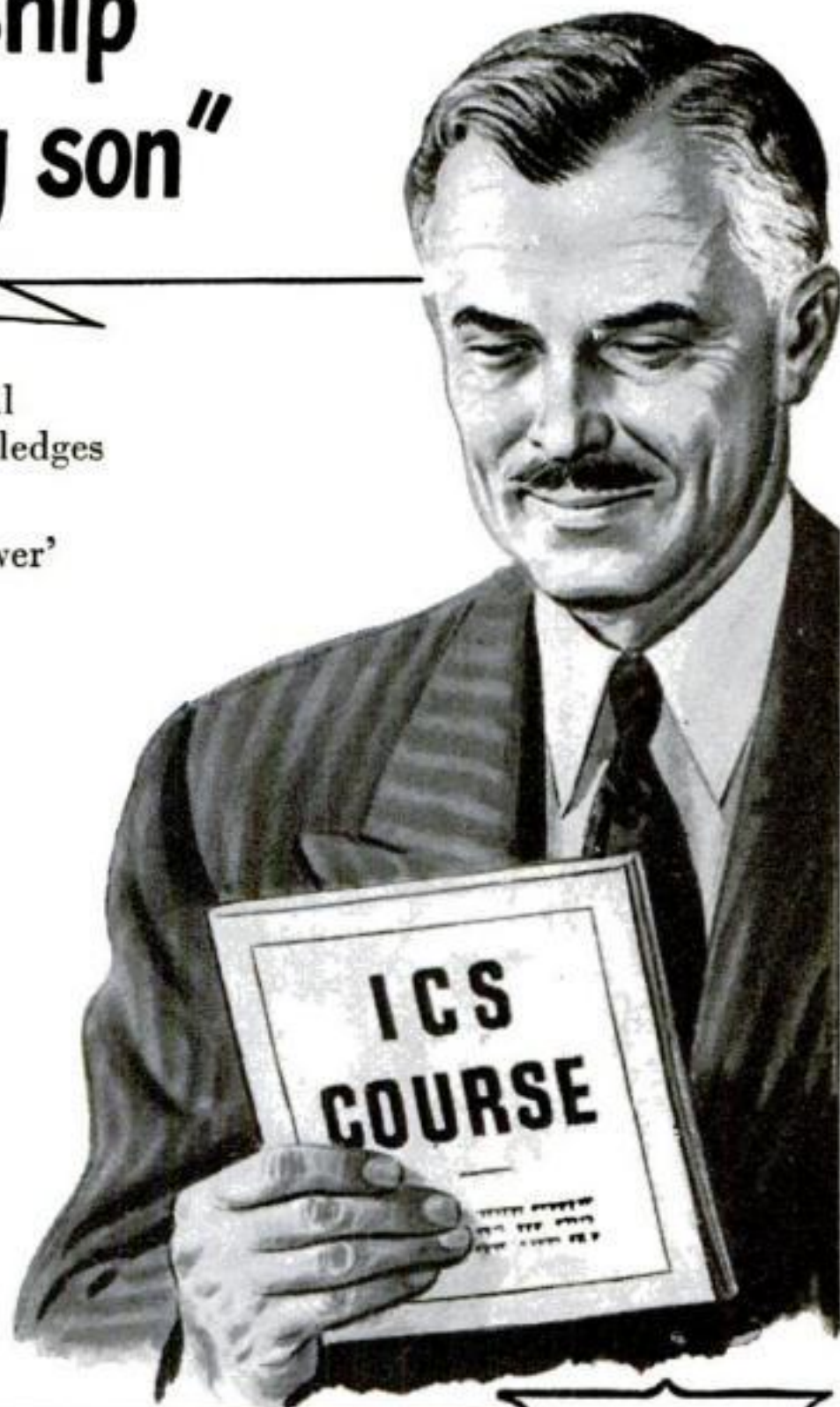
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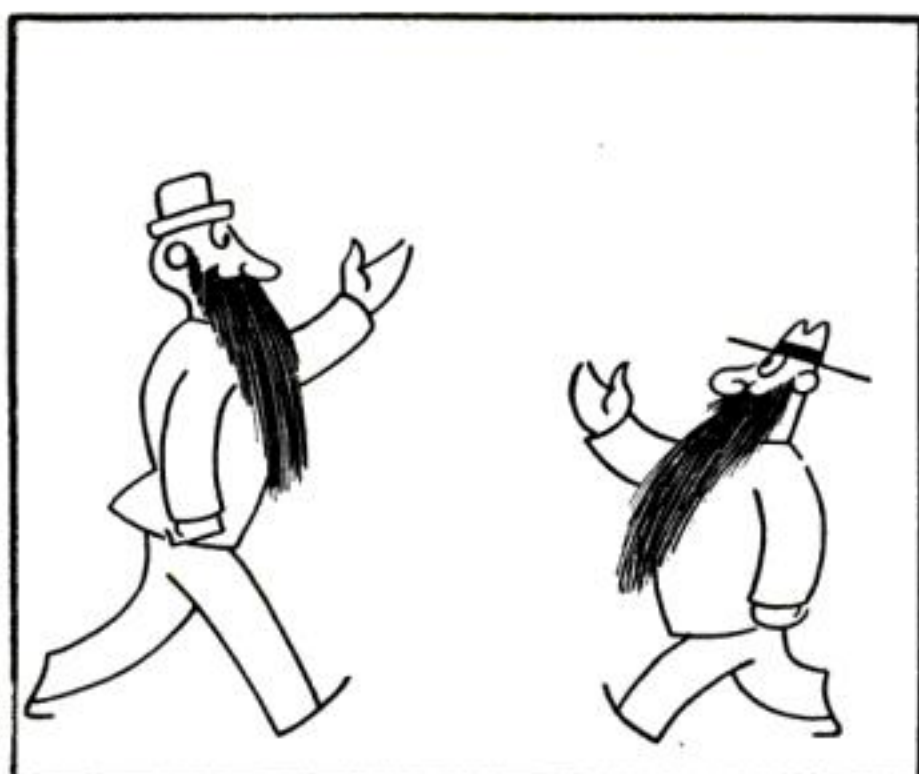


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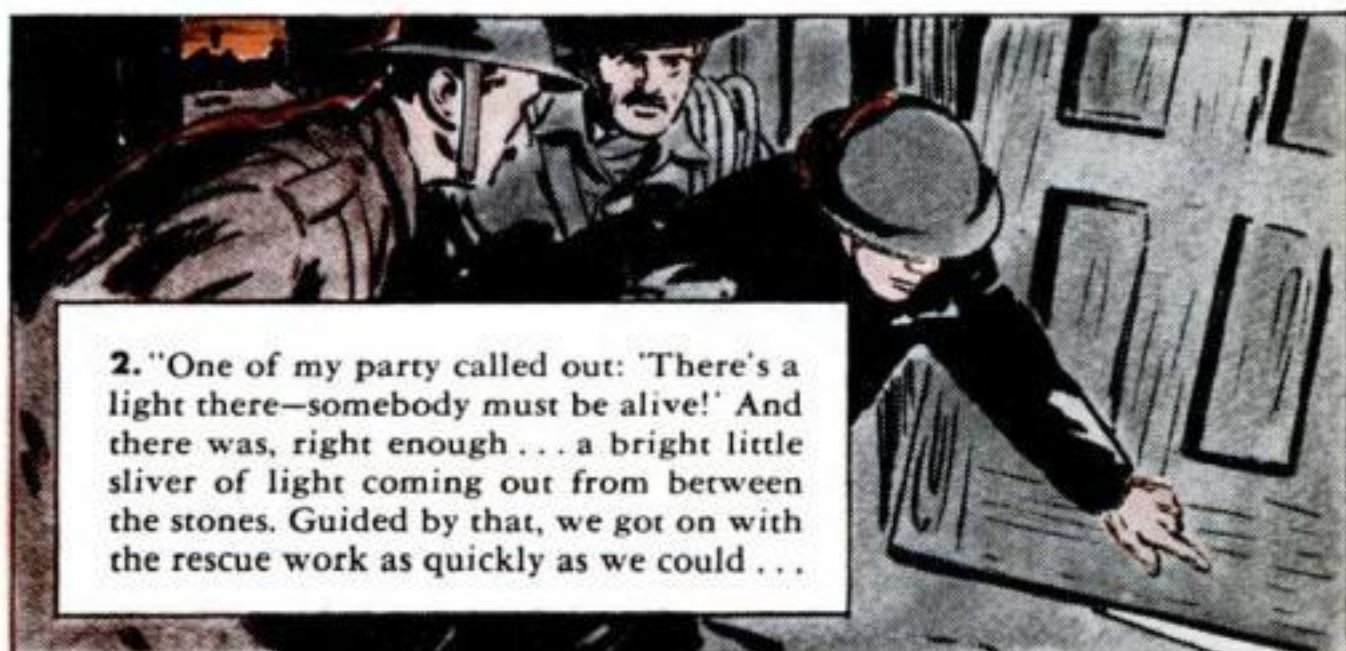
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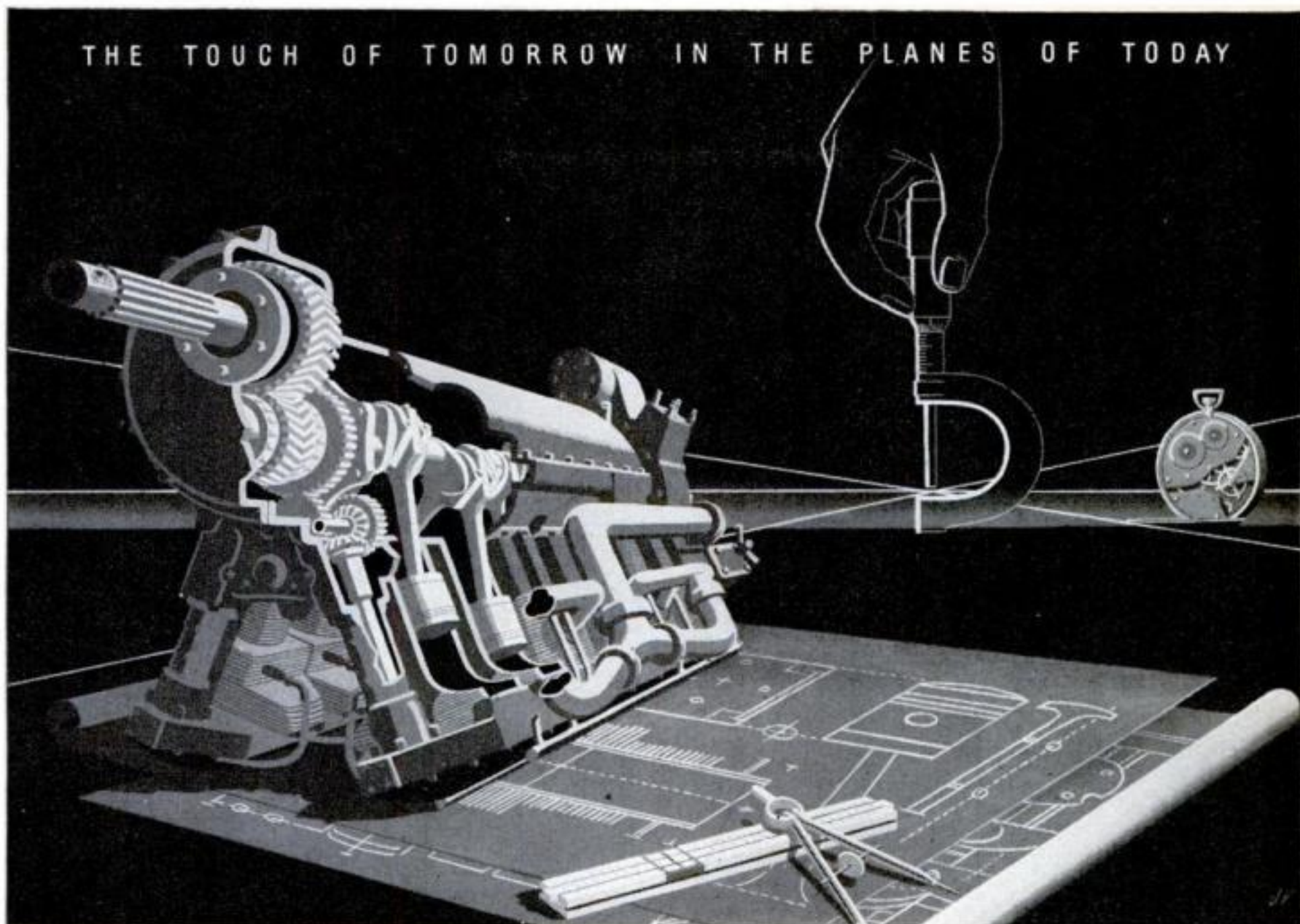
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| <input type="checkbox"/> Architectural Drafting | <input type="checkbox"/> Electrical Drafting | <input type="checkbox"/> Mechanical Engineering | <input type="checkbox"/> Shipfitting <input type="checkbox"/> Shop Practice |
| <input type="checkbox"/> Architecture | <input type="checkbox"/> Electrical Engineering | <input type="checkbox"/> Mine Foreman | <input type="checkbox"/> Steam Electric <input type="checkbox"/> Steam Engines |
| <input type="checkbox"/> Auto Engine Tune-up | <input type="checkbox"/> Electrician | <input type="checkbox"/> Navigation <input type="checkbox"/> Patternmaking | <input type="checkbox"/> Steam Fitting |
| <input type="checkbox"/> Auto Technician | <input type="checkbox"/> Electrical Maintenance | <input type="checkbox"/> Plastics <input type="checkbox"/> Plumbing | <input type="checkbox"/> Structural Drafting |
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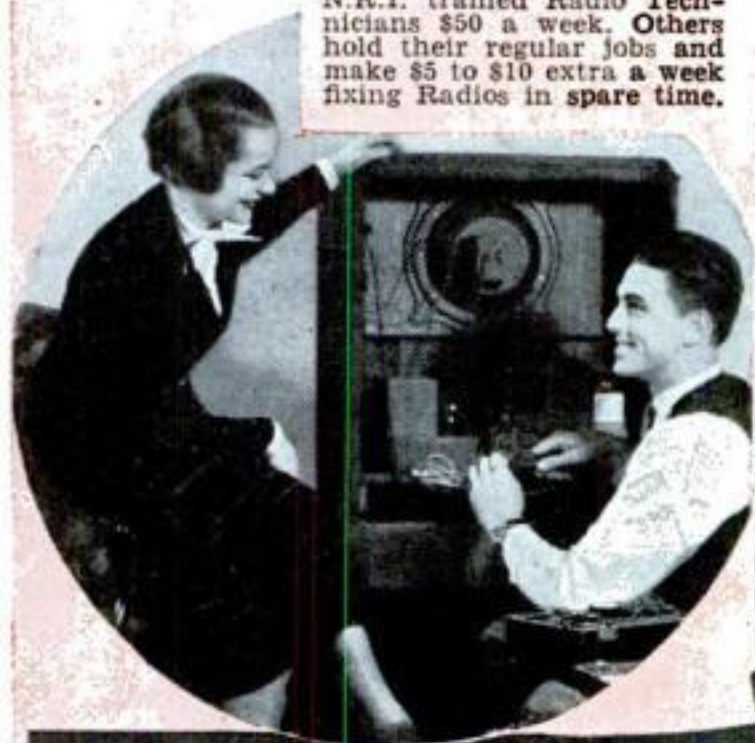
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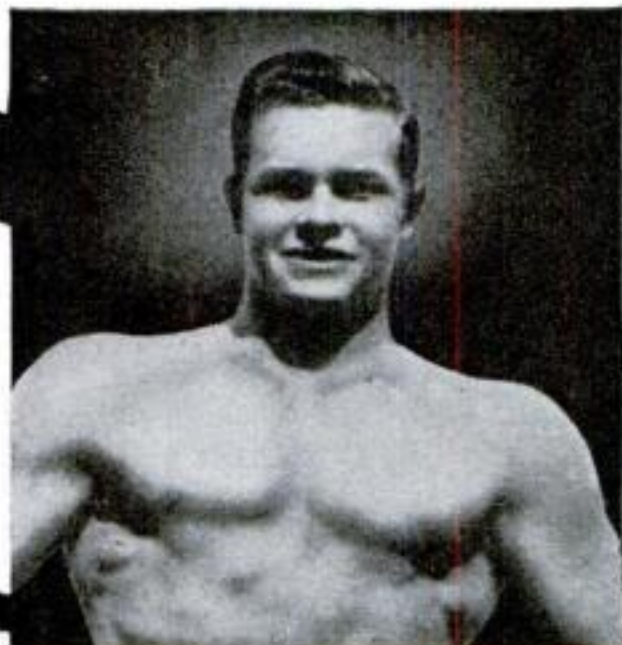
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Readers Say:

P.S.M. Meant Sleeve Stripes to This Sailor

I'M SEVENTY years old and have been reading your magazine for a long time now. I look forward to its arrival every month, and

-BUT I'M STUDYING
TO BE A WAVE



he was a youngster in school.—J. E., New York, N. Y.

I want to congratulate you on how well you tell what is going on in the world of science in language we ordinary folks can understand. Incidentally, my son, who is a lieutenant in the U. S. Navy, recently told his young daughter that the reason he is an officer is because his old dad made him read P. S. M. when

Put This in Your Pipe and Clean It

BEING always glad to make someone's pipe dream come true, I am hastening to answer E. A. R., of Rye, N. Y., whose letter appeared in the August issue, and who wants to know how he can keep his pipe clean now that pipe cleaners are off the market. It's easy, E. A. R. Just get a piece of wire long enough and thin enough to be bent double, and then run it through the mouthpiece into the bottom of the bowl. Then take a piece of white string and pass it through the loop of the wire. Now pull the string through the entire length of

the stem. Don't use too heavy a string. If you do, it might stick in the stem—and when that happens, brother, you're in trouble. Following the string treatment, pour about a teaspoonful of denatured alcohol into the bowl and let it stand for about five minutes. Then empty the pipe and let it stand overnight. When you "light up" next day you will find your pipe has acquired a delicate liqueur-like flavor.—L. C. B., Binghamton, N. Y.

IN ANSWER to E. A. R.'s plea for help, I suggest the use of compressed air, the kind that is to be found at any gasoline station. Just put the end of the air hose into the bowl—and let 'er blow. You'll have a clean pipe in one good "puff."—J. V. S., Campbell, Ohio.

I OUGHT to make E. A. R. hoe four rows of corn, beans, or any other of my vegetables he might choose—in payment for the valuable information I am about to give him. But I just can't sit idle and watch a fellow pipe smoker suffer. I suggest that he get a good clean wing or tail feather from a hen or rooster and use that to clean his pipe.—A. L. L., Edgewood, R. I.

YOU MEN—you're all alike. Always trying to do an easy thing the hard way. There's a store on 42nd Street near Lexington Avenue that sells pipe cleaners in packages of 12 for five cents, one to a customer. I've known this for a long time, and I'm no pipe smoker.—A Red Cross nurse, New York, N. Y.

The Harder the Day, the Dizzier the Dog

REGARDING the discussion that appears to be raging in the columns of "Readers Say" on why a dog makes a number of turns before lying down, I

47 MORE TURNS
AND I'LL HAVE
DESSERT



believe I have at last found the real reason. In times past it became so hard to make a living that before a poor dog could lie down to his well-earned rest it was necessary for him to make several turns before he could *make both ends meet*. If you watch carefully you will notice that in these days of meat shortages a dog often takes an extra turn just to make sure. No fools, these dogs.—W. D., Tulare, Calif.

Out on a Limb

ABOUT WHAT BATTERY TO BUY ?



BUY THE BATTERY THAT IS THE CHOICE OF EXPERTS

When you buy a battery you won't be out on a limb—if you are guided by the experts who choose batteries for the world's toughest transportation services. For example a million-mile trans-ocean flying record has just been established by a Pan-American Clipper equipped with Auto-Lite batteries.

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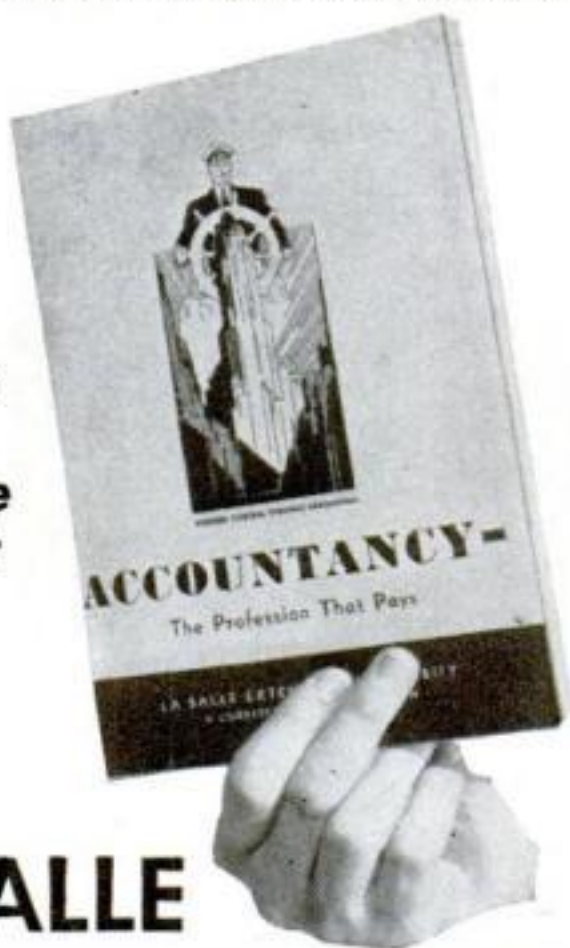
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Ever Think of Looking for a New War Gas?

IN YOUR June issue some amateur chemist wrote of his discouraging experience in attempting to make synthetic rubber. I also tried this same experiment — and had approximately the same experience. In my case, the concoction caught fire, so I threw it in the sink and walked out of the house. That was my second mistake. When I came back I found that, instead of rubber, I had succeeded only in cooking up one of the vilest odors that has ever assailed the nostrils of man. I know I did something wrong. What would you suggest I do if I attempt this experiment again? —J. G., Los Angeles, Calif.



Why Worry? Hitler Thinks They Move Fast Enough

ONE THING that has always puzzled me is why an artillery shell, being flat at its back end, is not seriously retarded in its flight by the suction it must create. I may be all wet about this, but I'm darned if I can figure out why a shell should have a blunt end in these days of streamlining. Wouldn't a tapered end help to speed a shell on its way? Another thing—why don't you put out a supplement with just "Readers Say" letters in it. After all, what your readers say shows what your public is most keenly interested in.—S. E. W., Dunkirk, N. Y.

"Readers Say" Is Going to the Dogs

I HAVE been reading in your magazine why it is that a dog turns around several times before lying down. What I want to know is why does a cocker spaniel stretch out his hind legs when he is lying down? He is the only dog I have ever seen do it. Can any of your "dog-gone" readers explain this for me?—C. A. B., Plymouth, Wis.

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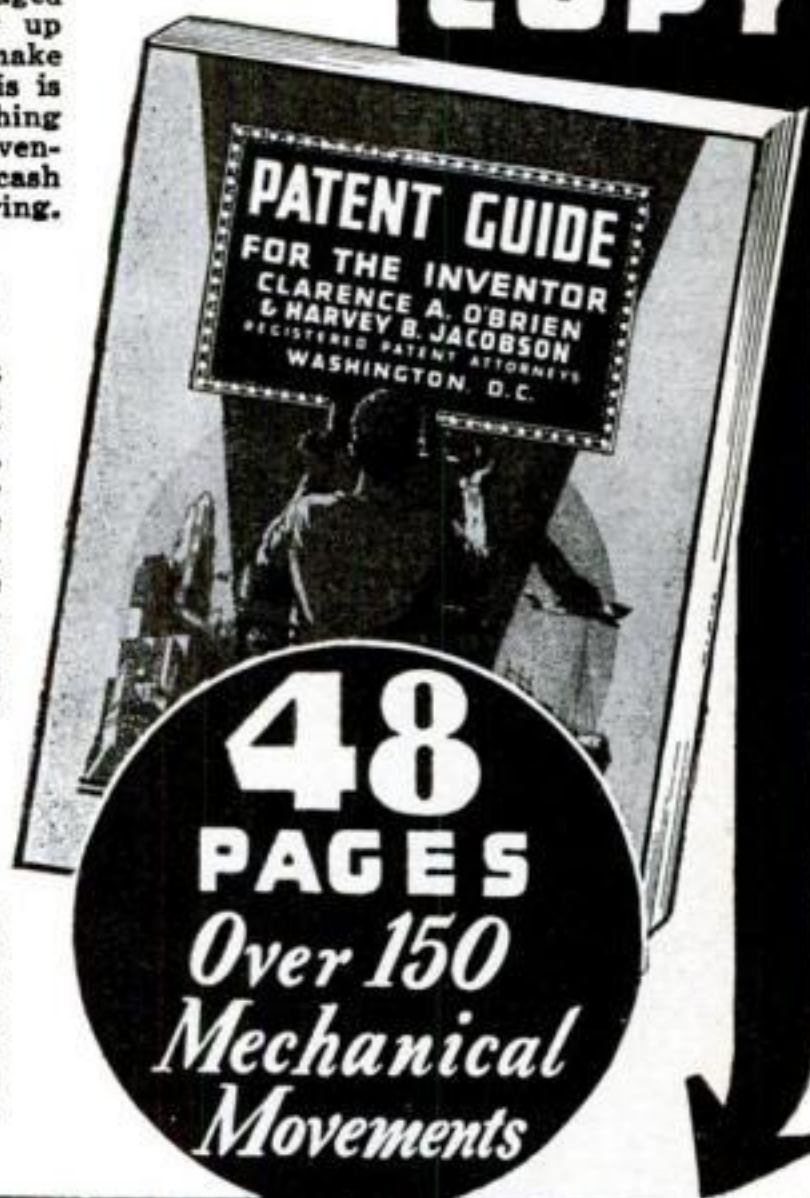
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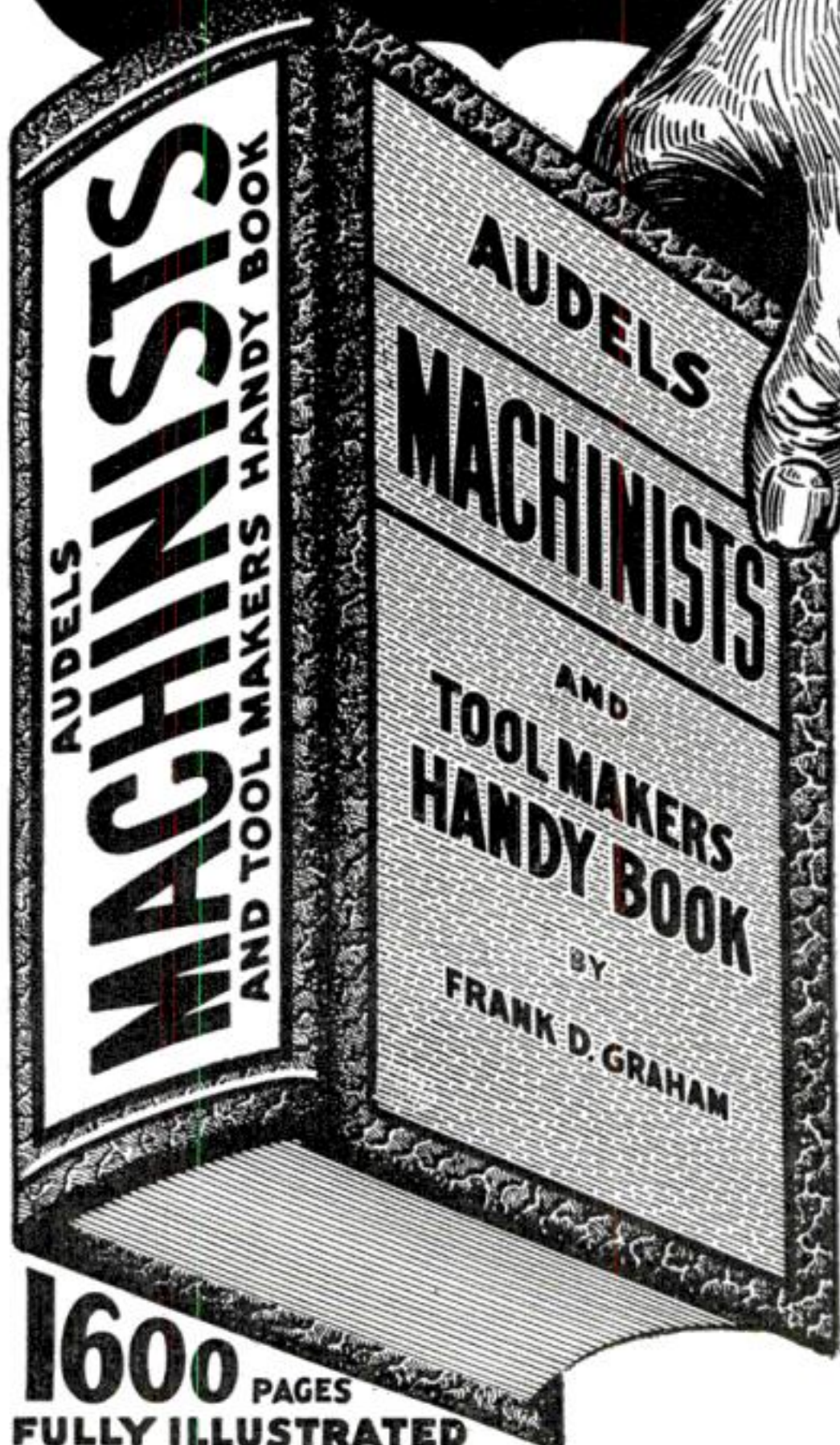


means of invisible writing, and I believe that if my suggestion were to be adopted it would save the lives of thousands of our American boys. The use of microfilm would also conserve valuable cargo space in our vessels.—L. S., Long Island City, N. Y.

Even the Way She Went Down was Titanic

FRANKLY I was a little amazed to find in the August "Readers Say" a letter stating that the author had been informed that the *Titanic* (the famous giant liner that piled up on an iceberg some 31 years ago) had not sunk to the bottom of the ocean, but was still floating around a few feet below the surface. I'm no physicist, but I know a few facts about this famous sinking that may help to clear up the question your correspondent has suggested. The *Titanic* had 16 watertight compartments and a double bottom. When she hit, a spur of ice gashed a 310-foot hole in her, and ripped open the forward five compartments. As she began to sink, other compartments also slowly filled, the stern finally rising up out of the water until the boat was almost perpendicular. At this point, all the heavy machinery fell forward and probably tore out the bow. Does it seem possible to anyone that in view of all this damage the *Titanic* could still be floating around somewhere in the ocean?—L. S., Baltimore, Md.

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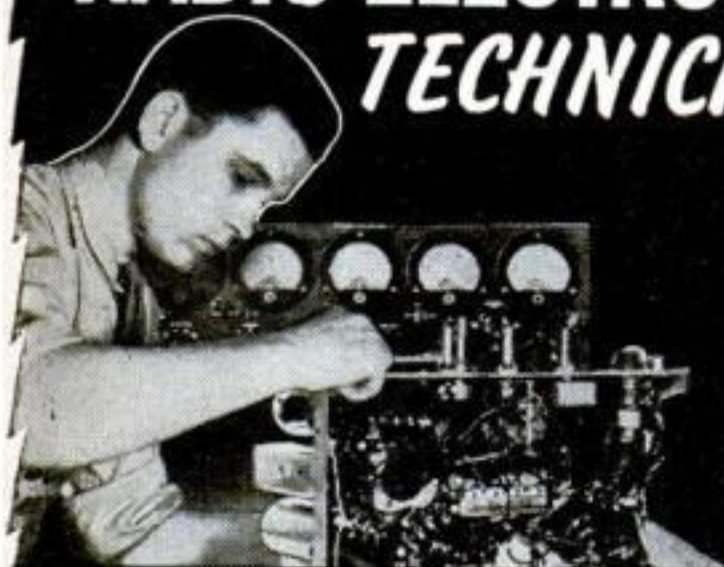
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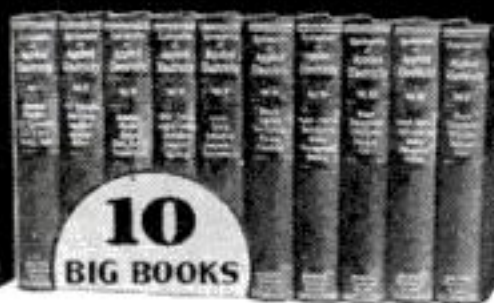
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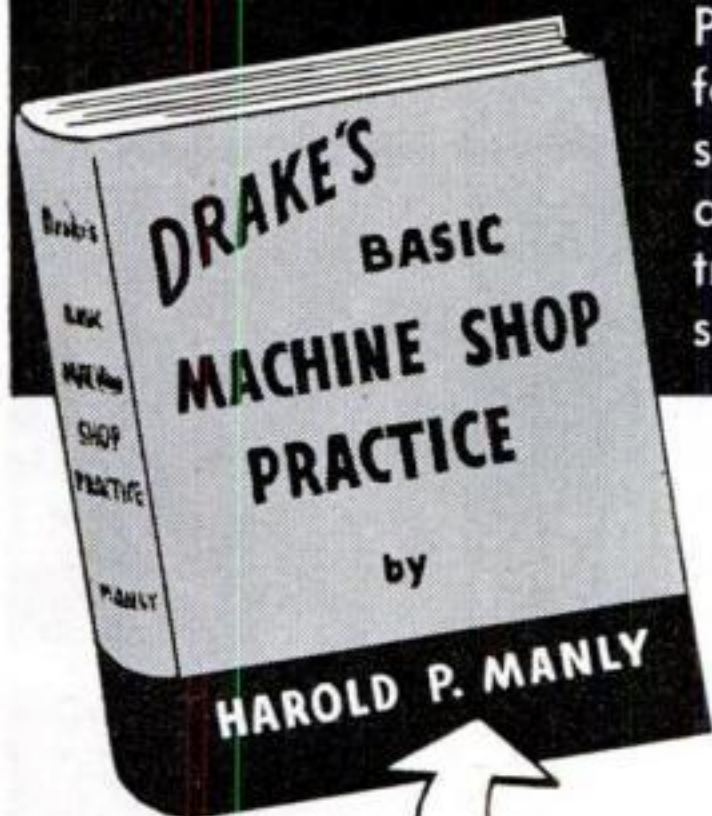
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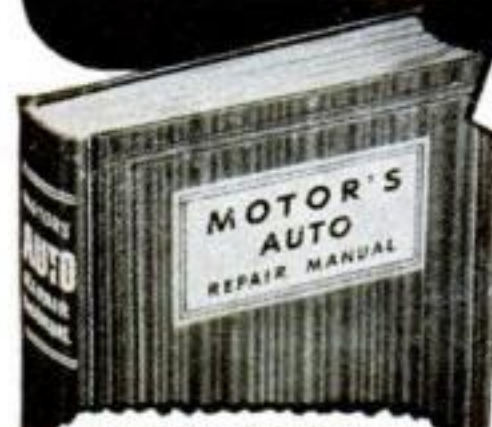
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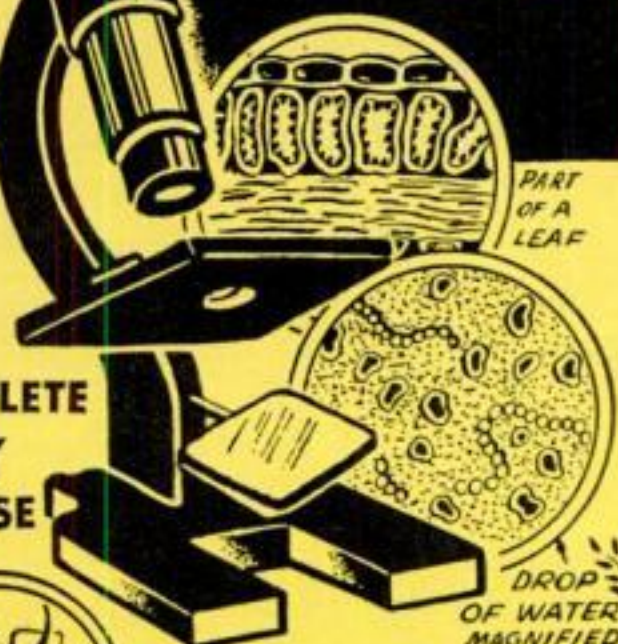
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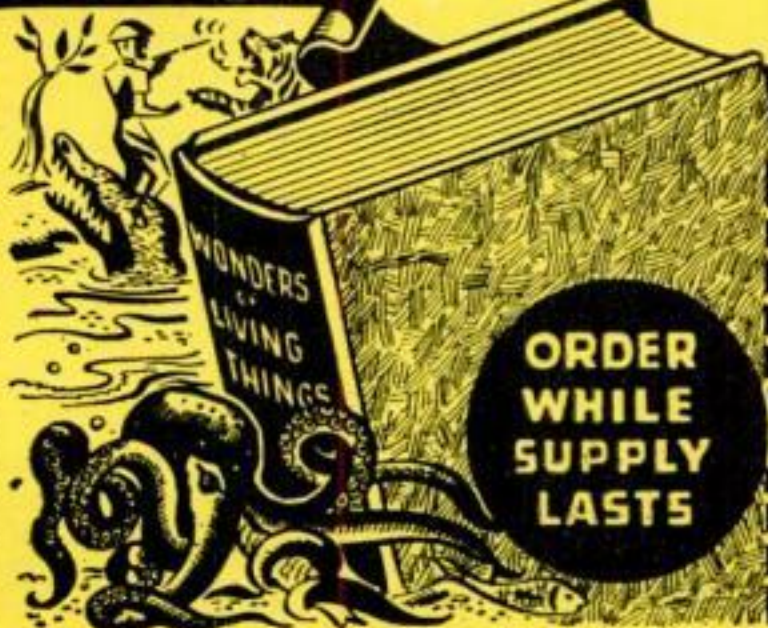
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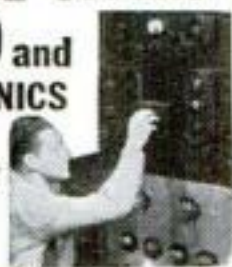
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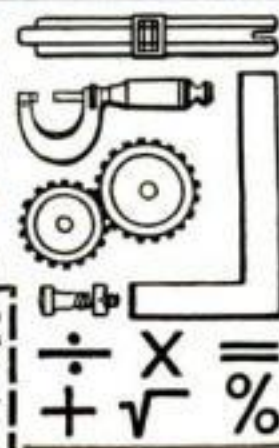
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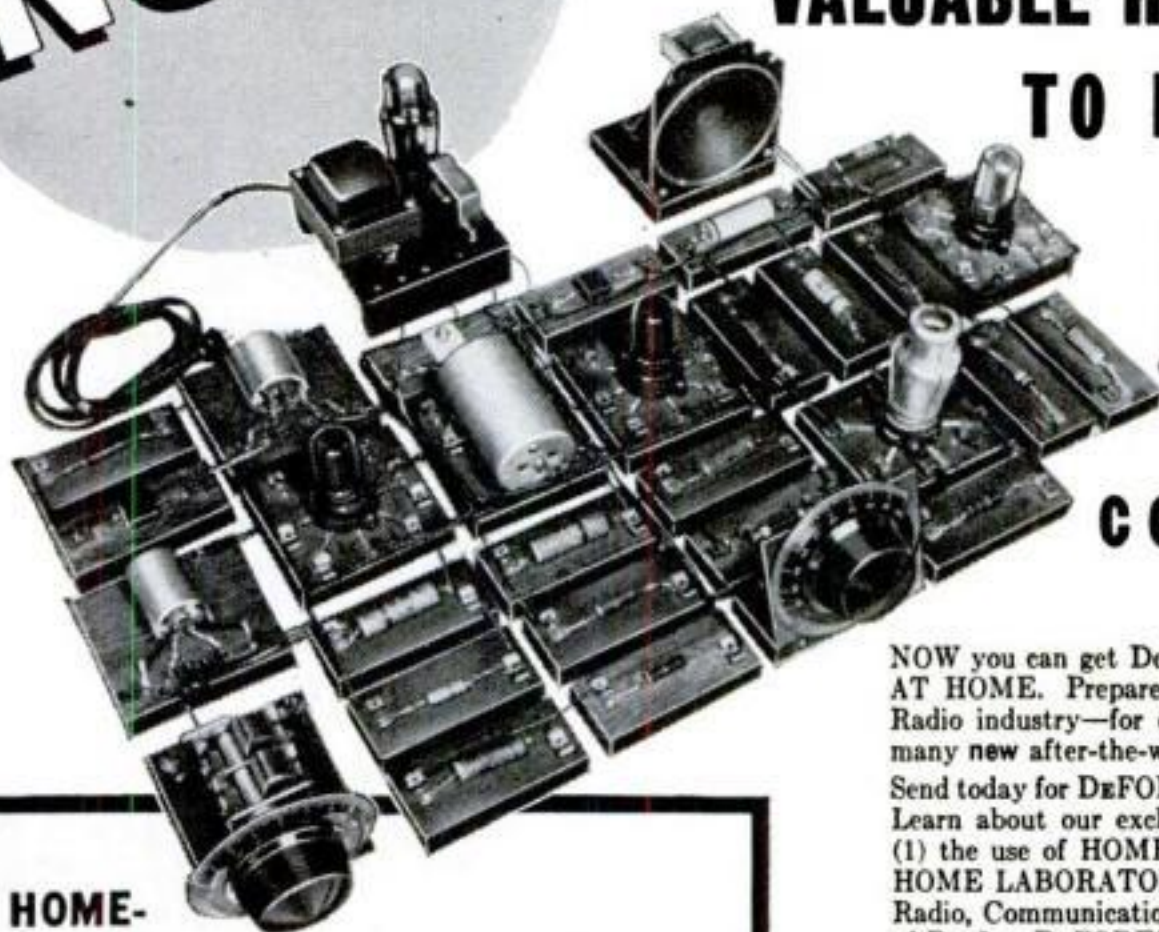
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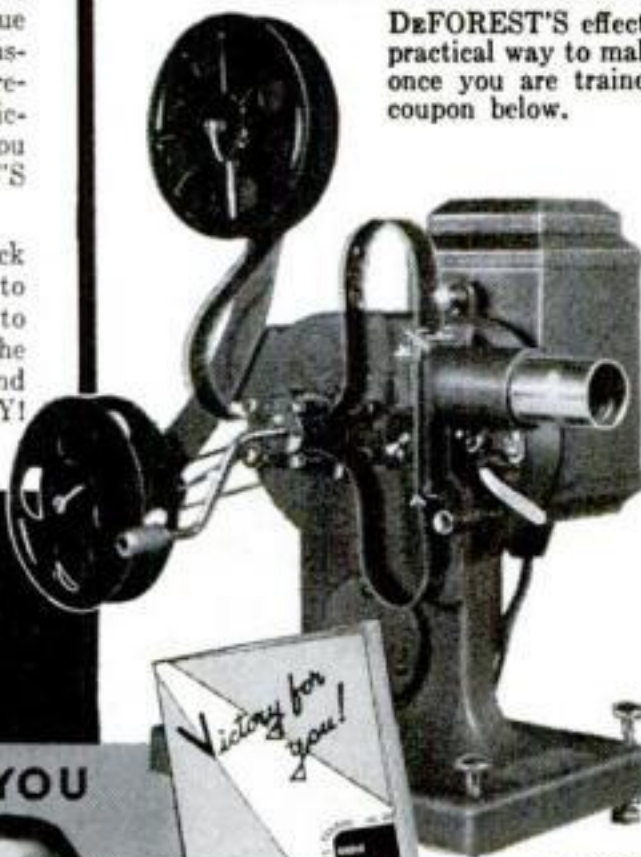


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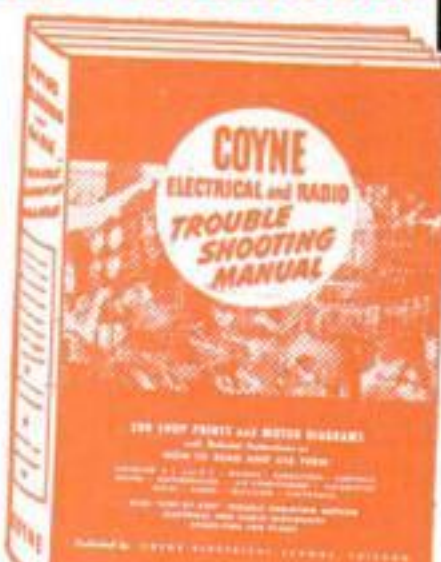
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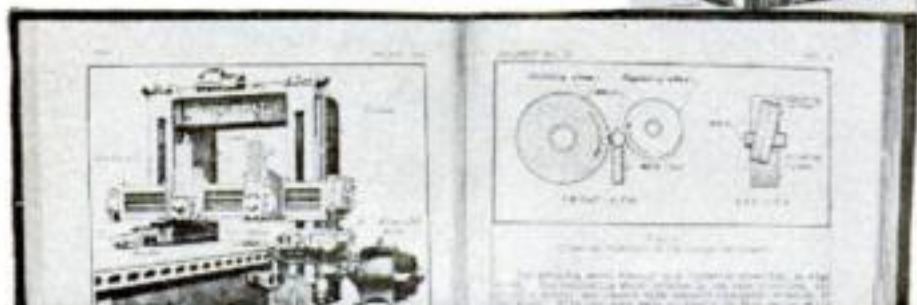
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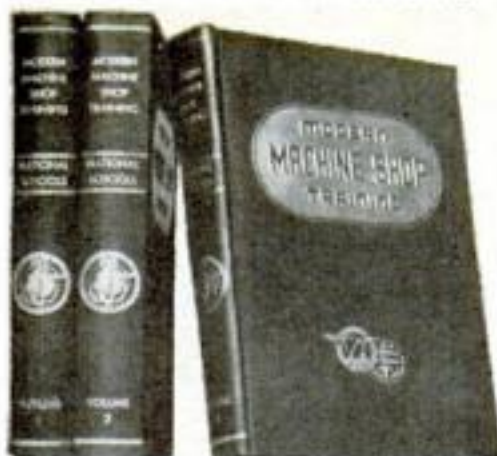
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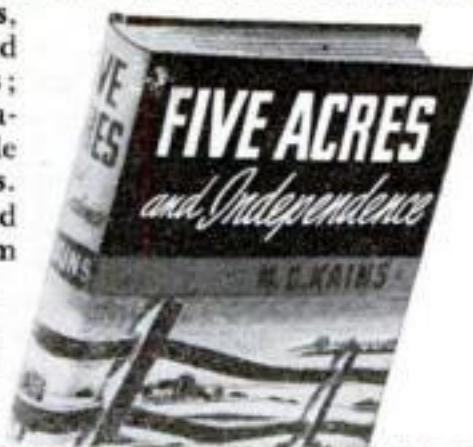
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19TH Century U. S. Commems., Civil War Revenues, Battleships, \$5 & \$10 Stamps Free to U. S. Approval Applicants. Metropolitan Stamps, 198-G Broadway, New York.

118 DIFFERENT stamps including Commemoratives, Charities, Airmail, sets, etc. 3c with Approvals. We buy Stamp Collections. Badger Stamp Company, Milwaukee S-3, Wis.

BRITISH Empire Collection! Burma, Cyprus, Gwallor, Sarawak, Tasmania; Also 50 other British. Only 5c with Pictorial, and Commemorative Approvals. Lyman, 97 Nassau, New York City.

GIVEN! Fifteen sets including U. S. Army, Navy, Pair, Famous Americans, British Jubilee and Coronation, and others—5c to approval applicants. Baldwin Stamps, Hawthorth, N. J.

FINE Approvals, freshly mounted. Fast, personal service. Tell me what countries you prefer and I'll send their stamps. Milton Skinner, 345 East Ocean, Long Beach, Calif.

FREE! Complete "United States" stamp catalog with 1,000 illustrations! Send 3c for postage. Harris & Co., 99 Transit Building, Boston, Mass.

SOLOMON Islands, Seychelles, Nejd, Caymans, Manchukuo, Brunei, Everything 3c with approvals. Viking, 130 (P) Clinton St., Brooklyn, N. Y.

PHILATOPIA Monthly Free—Forty pages—profusely illustrated. Includes Stamp Encyclopedia. Empire Stamp Company, Dept. PR, Toronto, Canada.

FREE—Your choice of any 10 stamps from our first U. S. Approval selection. Illustrated list included. Cosmopolitan Stamp Company, 1457 Broadway, Dept. 6P, N.Y.C.

UNITED STATES approvals complete coverage fine quality, attractive prices. Seminole Stamps, Box 436, Coconut Grove, Florida.

GRAF Zeppelins, other expensive stamps of your choice Free. Send Dime for details, packet commemoratives. Fair Stamp Company, Box 780, Bristow, Oklahoma.

SPECIAL—Airmails—23 different, including Zeppelin, Triangles, Latin-America, etc., 5c with approvals. Continental Stamp Co., Dept. C, Sandy Hook, Conn.

FREE—Canadian Sets, Royal Visit, George VI, George V, Coronation, Jubilee, Others, to approval applicants. Ensign, Box 118-P, So. Orange, N. J.

205 DIFFERENT stamps including Haiti, Johore, Perak, Selangor, Triangle, only 10c to approval applicants. Reich Stamp Co., 4647 Kenmore, Chicago, Dept. S6.

MEXICO Census Commemorative Set. Free with approvals. Pladon Stamps, 1717-S Idaho, Toledo, Ohio.

U. S. Honors Luxemburg stamp plus large Luxemburg packet 5c approvals. Minuteman, 516 Massachusetts, Lexington 73, Mass.

1 LB. U. S. Mixture 33c, 52 page list. Newhussman Stamp Co., 1122 Pine St., St. Louis, Mo.

EAGLE Album Stamp Pages with your own Personal titles. Samples Free. Mangoe, 555 So. 20th, Newark, N. J.

SPECIAL—Send Only 25c For Packet The Better Kind Approvals With Purchase. Simmons, Box 10, Station Jay, New York.

106 U. S. A. and foreign stamps for 10c; Approvals. Gus Heil, 63-43 Alderton, Elmhurst, N. Y.

STAMP Dividends. Details with approvals. Armstrong, 40 Jeanette, Youngstown, Ohio.

U. S. 50 Different 5c to Approval Applicants. Neumann & Co., 1506 W. Oklahoma Ave., Milwaukee 7, Wisconsin.

BARGAINS in fine approvals! Write today! International Stamp Co., Hallettsville, Texas.

TWO new issues, Free French sets, 10c with approvals. Vargo Stamps, Racine, Wisconsin.

U. S. Mint: Nos. 264, 267, 408, 441, 499, 529, 544, 617, 658, 50c. Approvals accompany. Horace Paine, Westport, Conn.

WHOLESALE Approvals of pictorials, new issues, etc., sent to reliable small dealers. Raymond Koch, Muscoda, Wisconsin.

FREE! World wide packet; Approvals. Kratzer, 143 S. Sedgwick, Wichita, Kansas.

A \$2,000 stamp plus 50 different, 3c with approvals. O. Knopp, Box 1381, Bristol, Conn.

FREE! Western Hemisphere Packet. Postage 3c. Owens, 801 Welshbldg., Baycity, Mich.

FREE!!! British Empire Packet. Postage 3c. Williams, 601 Archerbldg., Baycity, Mich.

FREE! Pony Express set (facsimiles). Postage 3c. Roberts, 401 Shearerbldg., Baycity, Mich.

55 DIFFERENT United States 5c with Approvals. Bookman, Box 145-P, Maplewood, N. J.

100 DIFFERENT United States 10c. Monjar, 1750 Fairmount, Cincinnati, Ohio.

10 FINE U. S. 1862—1903, 3c. Weston, Box 20, Oklahoma City, Oklahoma.

UNITED STATES Stamps on approval. Large stock. Box 488A, Minneapolis.

PENNY Approvals that satisfy. Neil Gronberg, Box 5441S, Philadelphia 43, Penn.

MINT set Manchukuo 3c, approvals, Eagle, 6043 Columbia, Phila. 31, Pa.

60 DIFFERENT U. S. 10c. Pricelist free. C. Seidenberg, Cassopolis, Mich.

1000 MIXED U. S. Old and New 25c, 2 lbs. \$1.00. Weatherby, Troy, Ohio.

TOBACCO—PIPES

DO you want a handmade full Queen size cigar for only 7½c each? 30% Havana guaranteed. No scrap filler. Send for free catalog and trial offer. Sidney Ram, 59 West Monroe, N-4, Chicago, Illinois.

TRAPPING

FOXES, Nine in one day. Trap all furbearers. Particulars Free. Guaranteed. Write—Estabrook, Sherburne, Vermont.

ELEVEN Box Traps. Complete blueprints, 30c. Wee-Sho-U, P. O. Box 51, Detroit, Mich.

TREASURE FINDERS

MT-SCOPE Metal Locator fully guaranteed and unsurpassed in efficiency. Time payment plan, trade-in and accessories. Free literature. Fisher Research Laboratory, Palo Alto, Calif.

WANTED—MISCELLANEOUS

WANTED Heavy Duty Moulding Cutter Set for Craftsman Tilting Blade 1943 Bench Saw, 5½" bore. Also Tenoner for same saw. R. Durfee, 54 Buell St., Hamden, Conn.

CASH For Bicycle Engines, Scooters, Motorcycles, Outboards, Gasoline Engines, Exercycles. Describe, quote price. Clymer, Los Angeles 15, Calif.

ACCORDION—any condition. Give description, price. Chaton, 600 Blue Island, Chicago.

CASH for used optical, mechanical, scientific instruments. Gordon's, 162-SB Madison, Chicago.

MERCURY (Quicksilver) we pay \$1.50 per pound. Western Metal Co., Bloomington, Illinois.

WELDING, SOLDERING

NEW model electric welder 110 volt AC-DC; will weld all metals; easy to use; full directions. Complete with power unit, flame and metallic arc attachments, carbons, fluxes, rods, mask; all for \$19.95—Used by the Navy. Marvel Electro Welder Mfg. Co., 195-AV Center St., New York City.

WELD, Cut, Braze with gasoline! New discovery. Make your own torch. Instructions one American dollar. Matthews Mfg. Co., Calgary, Canada.

SLIGHTLY used Arc Welders. Recommended by R. E. A. Guaranteed. Forney Mfg. Company, Ft. Collins, Colorado.

*Life smiles on the
man with*

Pipe Appeal



B LONDE or brunette—
they prefer the man who smokes a pipe!
But don't let 'em down! Follow through—
with true PIPE APPEAL! Put Prince Albert
in the bowl. FRAGRANCE to keep 'em
smiling—on a date—at home—in the office
—anywhere. GOOD TASTE to keep you
smiling—rich taste, yet *mild* and *mellow*,
easy on your tongue. P. A. is no-bite treated,
crimp cut—the world's largest seller. Keep
'em smiling with Prince Albert Tobacco—
PIPE APPEAL for all!

BUY WAR BONDS AND STAMPS

PRINCE ALBERT

THE NATIONAL JOY SMOKE

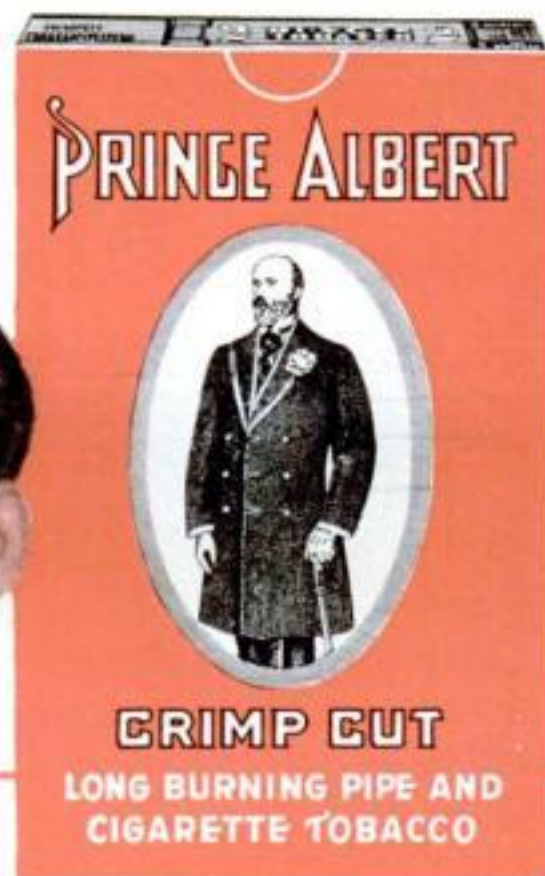
50

pipefuls of fragrant
tobacco in every
handy pocket pack-
age of Prince
Albert

70

fine roll-your-own
cigarettes in every
handy pocket pack-
age of Prince
Albert

IT'S THE NO-BITE
SMOKE —
THE RICH TASTE
COMES THROUGH
MILDLY!



EYES AND EARS OF THE ENEMY



**CAN WE SMASH
THE NAZI ESPIONAGE RINGS?**

How G-Men Trap Axis Spies

Using every means of scientific detection, the FBI is outwitting the Gestapo's best secret agents

By ARTHUR GRAHAME

IN A little waterfront tavern at Port Richmond, N. Y., few patrons even noticed the stoop-shouldered, 57-year-old porter, busy with mop and pail. Anyone taking the trouble to inquire would have learned that he operated his pleasant brick home in

near-by Tompkinsville as a boarding house for service men, and that he was one of the most zealous air-raid wardens to be found in the vicinity.

Yet, at this writing, he faces a long prison term or the electric chair, as a self-confessed Nazi spy. And a United States Attorney declares, "This is one of the most important arrests made in an espionage case in this country since the declaration of war. The FBI is entitled to full credit for its surveillance and eventual capture of this man."

His house, Federal Bureau of Investigation agents pointed out, topped the highest point on all of Staten Island. From his attic

HOW A NAZI SPY RING COLLECTS INFORMATION



Spying defense workers constantly seek for any production information that may help the Axis



A faked blowout near an airfield gives a spy a chance to study our latest airplanes



Shipping information is picked up by agents who make it a point to live in harbor areas



Boastful soldiers are easy victims for the pretty spy who is after military secrets



Our newspapers and technical journals are carefully read from cover to cover by trained agents



Barroom spies become admiring listeners when a carousing seaman begins to talk of cargoes



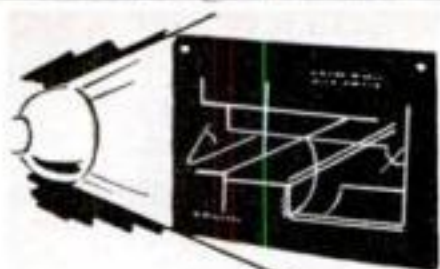
To the spymaster—with headquarters usually in a busy office building where his callers are not likely to be noticed—are brought hundreds of bits of information by the "collectors." It is then his job carefully to piece them together into a report and transmit the information to Berlin

windows he had a perfect view of Allied ships bound out of New York Harbor, and could relay information of the highest value to U-boats ready to intercept them. What he did not see for himself, he could pick up from careless conversation at the tavern where he worked—and at others that he made it his business to visit in off hours. His roomers, too, may have unwittingly furnished him with information of great importance to the Nazis.

Through underground channels, G-men

say, he was able to enlist the aid of a most helpful accomplice. Well trained in engineering, this man was employed in an Eastern airplane factory. The engineer could supply just what the Nazis particularly wanted—production figures for American planes, and diagrams of the latest models. Among other things, he turned over to his fellow-conspirator a complete set of highly confidential plans for a new bomber. Delighted with what he could now forward to his superiors in Germany, the Tompkins-

AND TRANSMITS IT TO GESTAPO HEADQUARTERS



A favorite method of transmitting information such as a blueprint or map is to microphotograph it down to postage-stamp size so that it can be easily concealed on the person of the courier



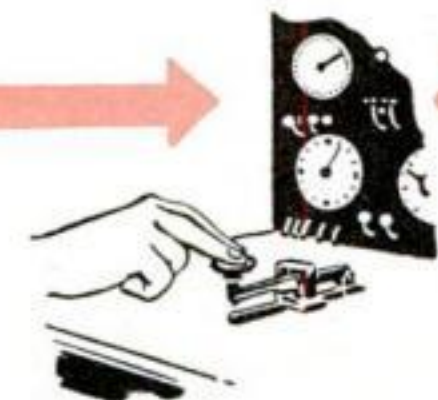
In the neutral country, the reports are received by agents who maintain spurious businesses and residences for that sole purpose



In the "mail drop" system, agents' reports, disguised as personal or business letters, are sent by air or regular mail to fellow agents in neutral countries, who forward them to headquarters



At Gestapo headquarters in Berlin arrives information that may have been picked up on a New York street corner, in a Chicago bar, in a San Francisco hotel—or in your own home



In an emergency, spymasters will transmit their information abroad by short-wave radio. The danger, of course, is that the location of the sending station will be revealed to the FBI agents

ville spy pressed \$100 into the engineer's none-too-reluctant hands. It was a handsome sum among Hitler's underpaid spies, even for the risk taken by the engineer. (He was to find out about that later, when FBI men caught up with him; he, too, has been arrested and has confessed.)

More industrious than imaginative, the Tompkinsville agent followed a familiar method—the "mail drop" system—to get his information to the Fatherland. He typed innocent-looking letters to "friends" in neu-

tral foreign countries. Victory gardens, Washington's Birthday, and California wine came in for mention, and there were expressions of pleasure at American victories over the Japanese. But the letters also bore, in invisible ink, information on arms shipments, troop movements, convoy sailing dates, and industrial production figures. To make the ink, the writer dissolved in water a white powder, which he had been told to call an eye wash if questioned. Traveling by Clipper mail planes, the letters were in-

tended to reach foreign Nazi sympathizers who would speed them to their destination.

The invisible ink, of a kind well known to expert searchers for hidden messages, was the one weak spot in an otherwise flawless setup. When the authorities examined the Clipper mail, they quickly detected it. Instead of going abroad, the letters went to the FBI, which took over the months-long task of tracing them back to the sender.

Of course, he had not been obliging enough to give a return address. The Tompkinsville postmark was the only clue. Questioning postmen, the G-men patiently ran down one false lead after another, until their search narrowed to the street where the suspect lived. When they finally nabbed him, his nearest neighbors were amazed to learn of his clandestine activities.

In the first World War our organization for combatting spies and saboteurs—of which this writer was a member—was a hastily improvised hodgepodge of several Government agencies and an amateur outfit whose well-meaning members had a disconcerting habit of getting under the professionals' feet at crucial moments. President Roosevelt averted a repetition of that mistake when, in 1939, he designated the Federal Bureau of Investigation and our military and naval intelligence services to handle all espionage and sabotage matters, with the FBI as the co-ordinating agency. Since then, the G-men have investigated thousands of cases involving reported espionage and sabotage. These range from honestly mistaken "scares" to life-and-death battles of wits with master spy rings.

No less than 174 "parachute landings" in this country were reported by anxious citizens between June, 1942, and last March, according to J. Edgar Hoover, director of the FBI. Every report was investigated and proved unfounded. What the observer usually saw was a bird or kite.

Similarly, at a time when "U-boats" were being sighted along the coasts in fantastic numbers, a high Navy official remarked, "They'll be seeing flying submarines next." He was right. A woman air-raid warden in an eastern coastal area agitatedly reported that a submarine was flying overhead. She had never before seen a U. S. Navy blimp.

Of the many fanatics and crackpots who have fancied themselves as "lone wolf" Nazi saboteurs, perhaps the boldest was a German who attempted to sell the formula of an antifreeze compound for airplane motors to the United States Government. FBI agents spoiled the deal when they overheard the German's private comment that a few drops of picric acid, added to the compound by a saboteur, would wreck each engine.

But these are small fry, compared with organized spy rings that the FBI has smashed. Headed by top-notch espionage men trained in a special German school, they work something like this:

In charge is a director—the spymaster. Usually he has his headquarters in a reputable and busy office building in which callers are not likely to be especially noticed, and conducts his affairs behind doors lettered with the name of a real or—more often—phony business concern. Reporting to him are a varying number of "collectors"

THREE OF THE DEADLIEST WEAPONS IN



STEEL PELLETS are a favorite saboteur's weapon. Capable of being handled unobtrusively, they can cause a lot of damage when put in the right place—such as the crankcase of a motor. Another effective weapon is a time bomb that can be set to detonate anytime within two weeks



BOGUS COAL like the piece shown above is a saboteur's dream come true. Ingeniously camouflaged so that it is practically indistinguishable from the real thing, this apparently harmless piece of carbon is actually a block of TNT. Two or three of these could wreck a power plant

who do the routine spying. All of them are inconspicuous people and most of them hold down inconspicuous jobs. They are waitresses in military-area lunchrooms who report that last night Private Smith was grouching because wearing the tin hat just issued to him gave him a headache; factory workers who tell the director how they overheard the super telling the foreman that the front office had got an order for 20,000 more of those machine-gun mounts; shabby men who sit all day in hall bedrooms, fine-combing newspapers and technical magazines for pertinent news items. Pieced together by a highly trained spymaster, dozens and even hundreds of these bits and pieces of information make up most model-1943 espionage reports.

Transmission by short-wave radio is of course the quickest means of overseas communication, and it is used by spies for sending news of ship sailings and large-scale troop movements—if (and in these war days it is a mighty big if) they dare use their transmitters. When speed in delivery is not essential, espionage reports usually are sent by air or regular mail, addressed to a "mail drop" in some neutral country—say, a spurious business office maintained for the sole purpose of receiving mail from spies operating in enemy or unfriendly countries and forwarding it to Germany or Japan. As in wartime all foreign-addressed mail is subject to censorship, espionage communications sent by post must be camouflaged to avert suspicion. Usually the camouflage is a natural-sounding business letter typed on one side of the sheet. This

DO'S and DON'TS



Be alert.

If you believe you have evidence of either spying or sabotage, report it immediately to the FBI.

Keep what you have reported to yourself. Repeating it to others might warn the spies.

Don't try to judge the importance of your observations. What may look trivial to you may prove to be a vital link to the FBI.

Don't be an amateur G-man. Once you have reported your suspicions, leave the sleuthing to the experts.

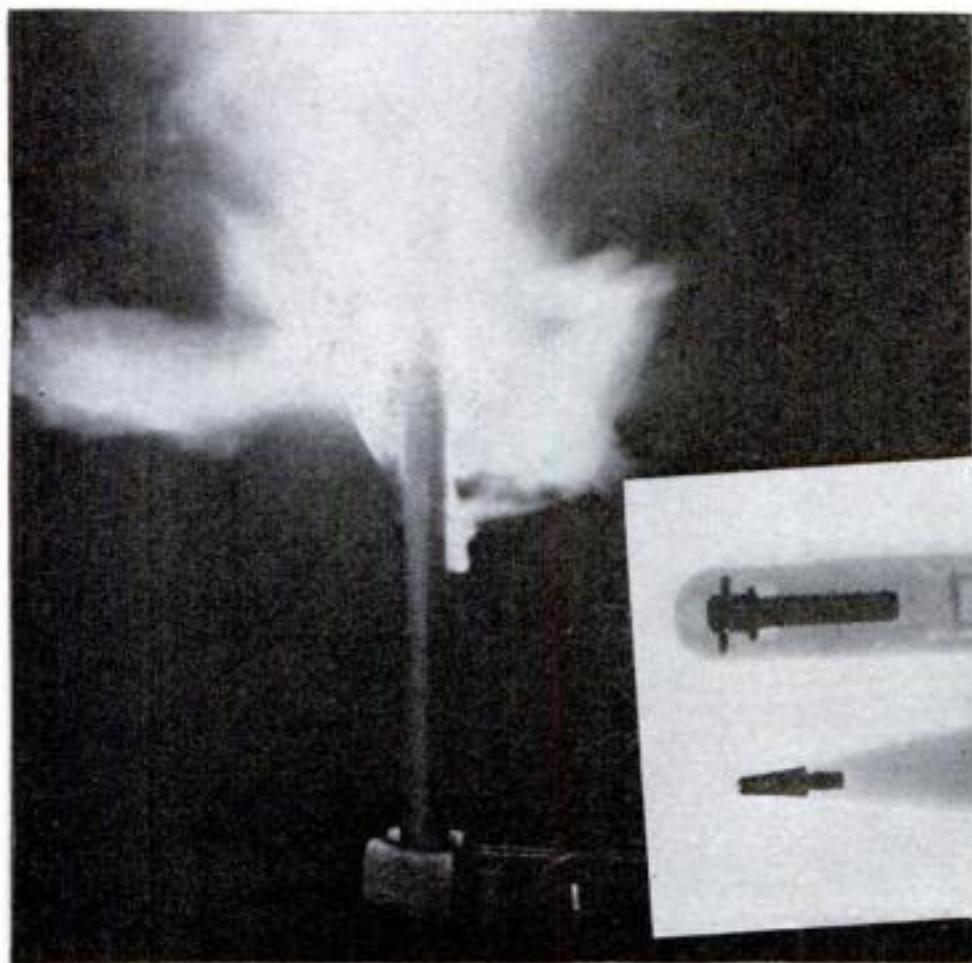


may be a coded message, or may serve as a blind for another in invisible ink.

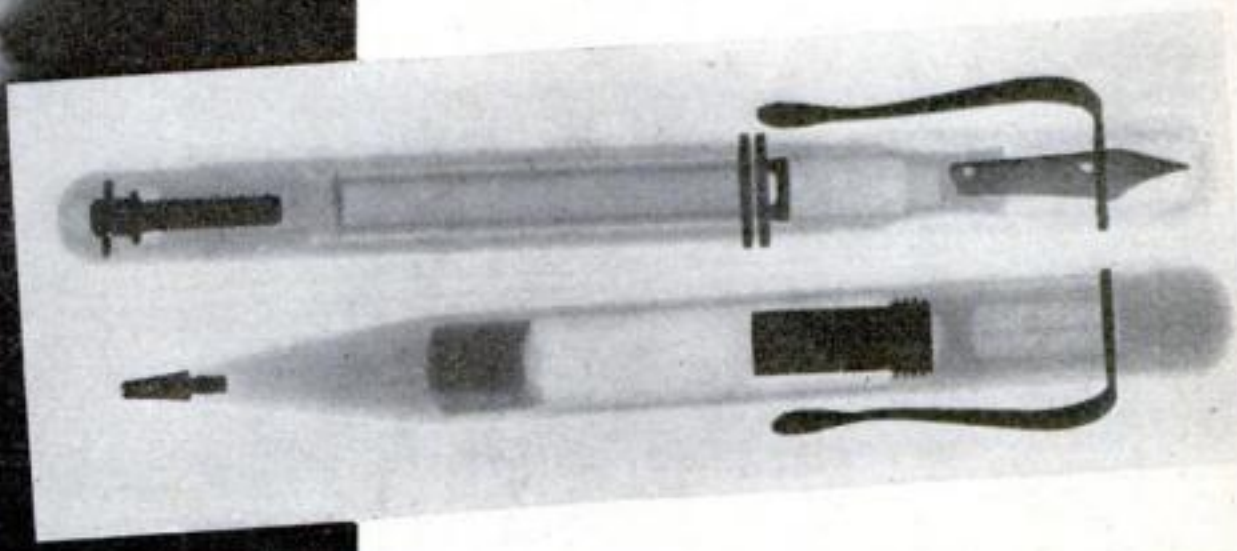
Blueprints, maps, sneaked tracings of designs and plans, and important documents which must be sent abroad in unabridged form usually are microphotographed, in the manner of a V-mail letter, by an expert assigned to the ring. The microfilm, little larger than a postage stamp, is carried concealed on the person of a courier.

Illicit radio transmitting stations are located so quickly and accurately by the many scores of Federal Communications Commission listening posts scattered all over the country that spies seldom risk using them unless they can be moved in a hurry.

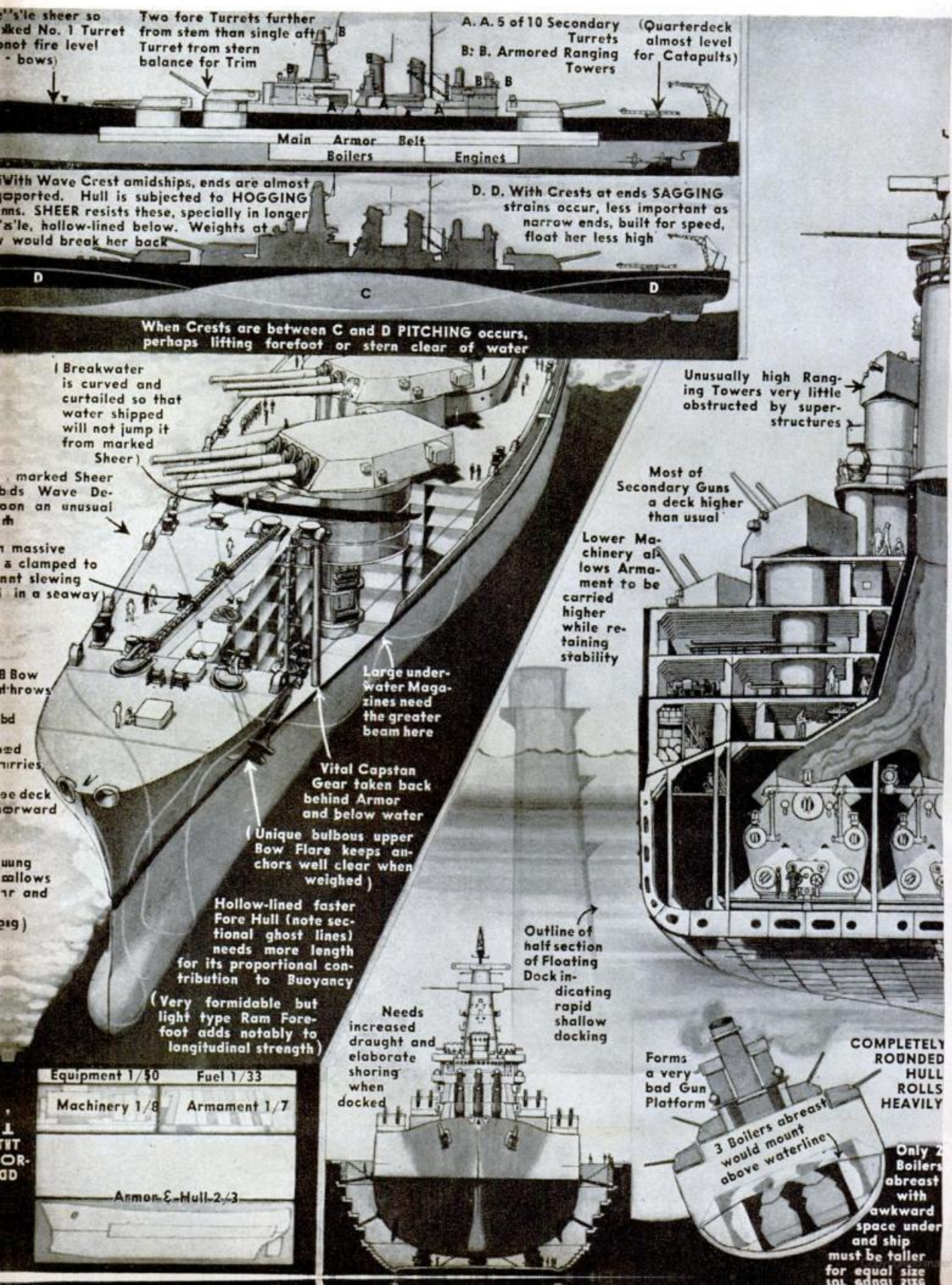
THE NAZIS' ARSENAL OF SABOTAGE



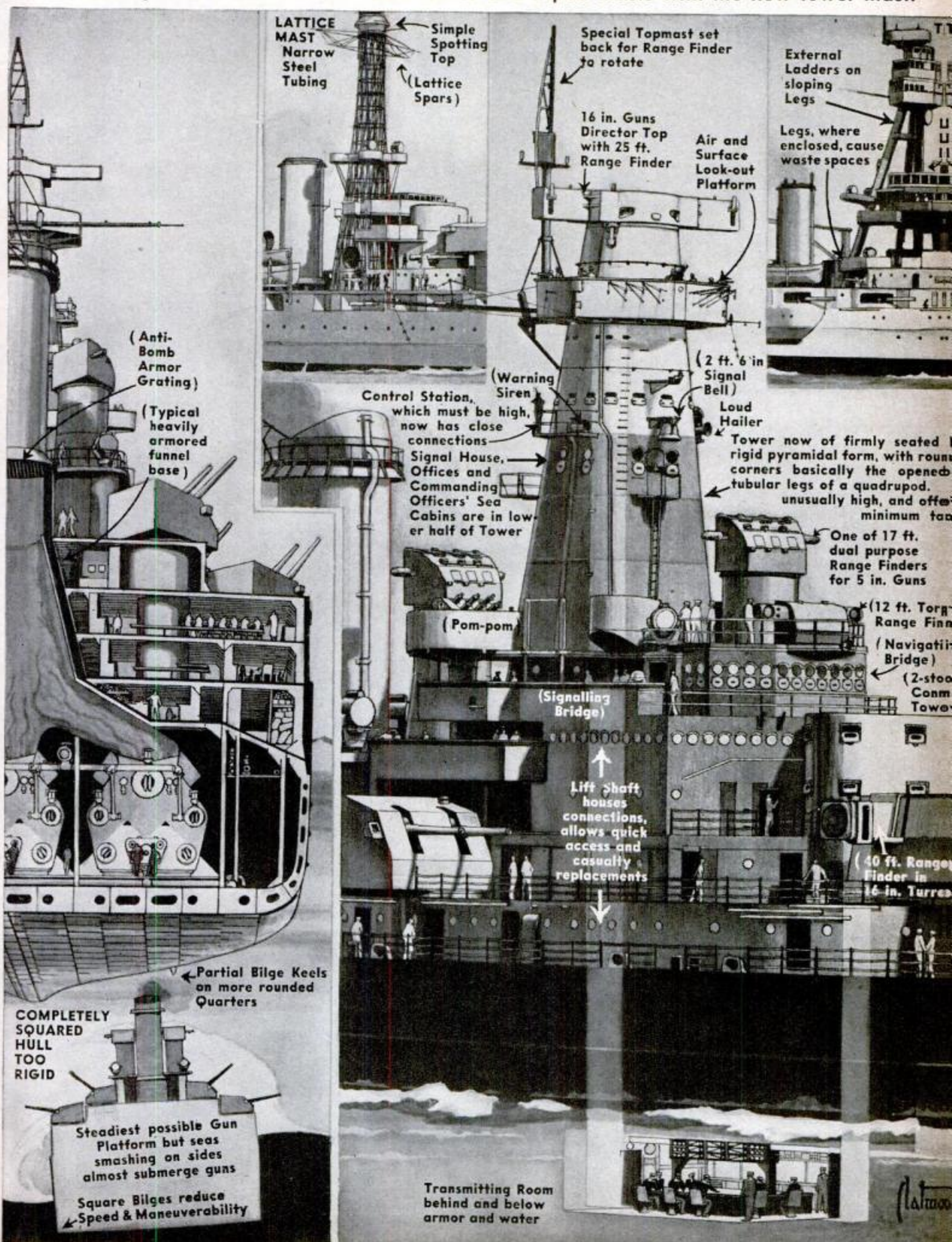
INCENDIARY PENS and pencils, so well made that a spy could carry them in his coat pocket without any fear of arousing suspicion, were part of the excellent equipment brought ashore by the eight Nazi saboteurs who landed from a submarine on the coast of Long Island, N. Y., and were caught. At left is one of the pencils at the moment of ignition. Below is an X-ray photograph of the "pen-and-pencil set"



HOW A BATTLESHIP WORKS



Where does a battleship's weight go? What kind of hull design should it have, and why? These and many other features of battleship design, as exemplified by the 35,000-tonners of our modern *North Carolina* class, are illustrated below by S. W. Clatworthy, noted British technician, in drawings from the "London Sphere." Insets directly below contrast outmoded lattice and tripod masts with the new tower mast.

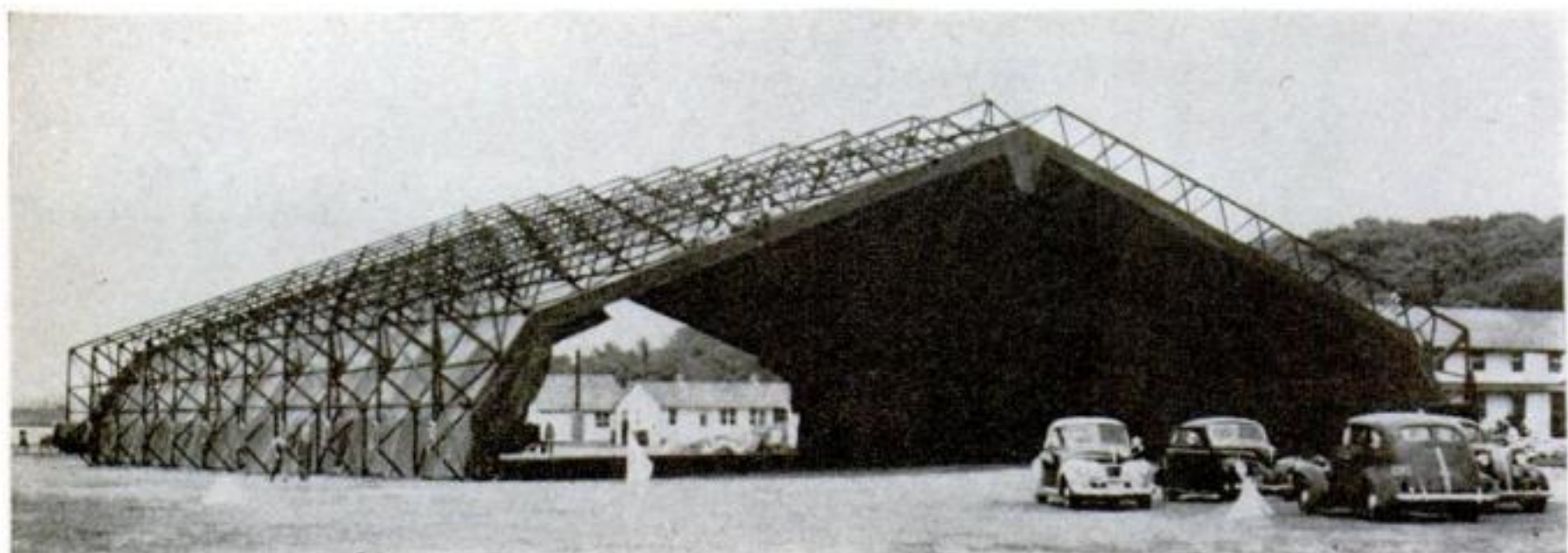
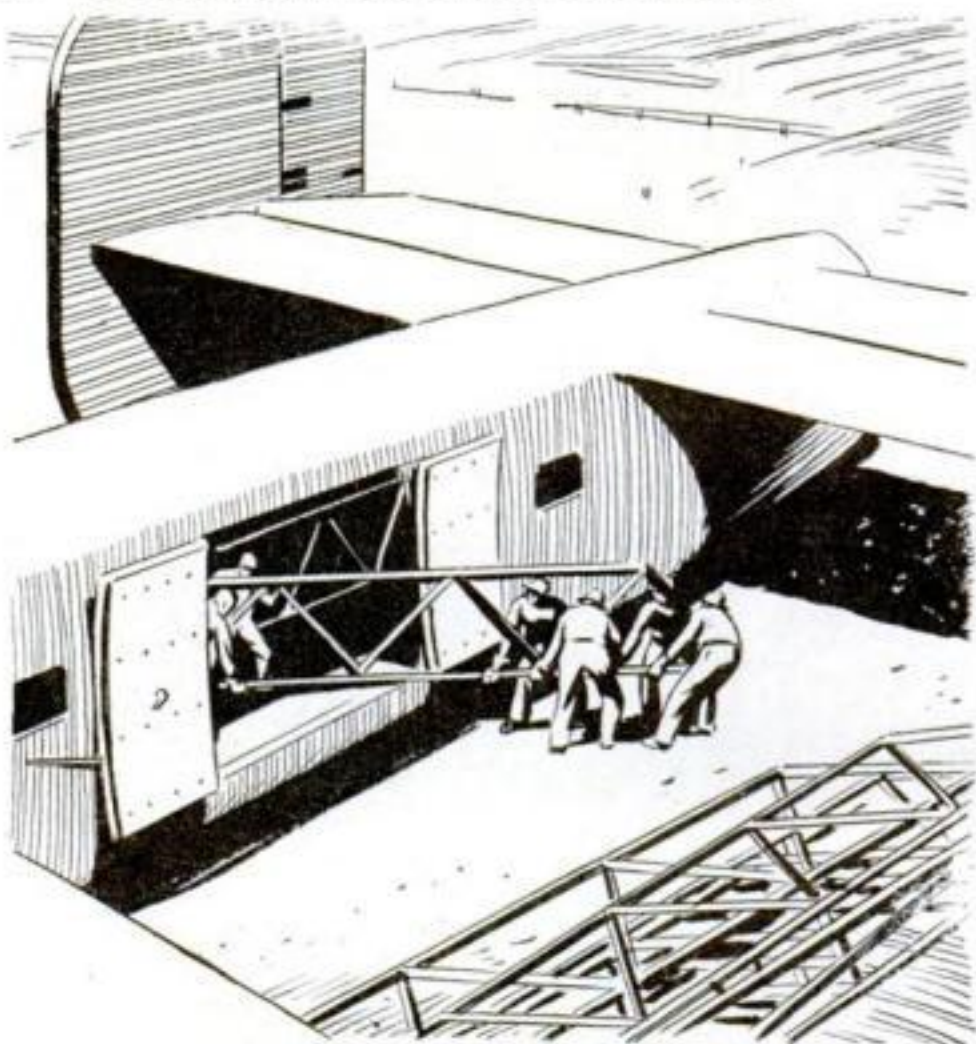




WATER JAVELINS that spray fog inside burning planes, and hand or tractor-drawn equipment trucks comparing favorably with full-size apparatus, are used by North American Aviation, Inc., to save flyers' lives, combat fires, and decontaminate areas affected by gas. Notified by pilot's radio of an im-

pending crash landing, asbestos-clad fire fighters are rushed to the scene, and within seconds can thrust the nozzles of water javelins through plane fabric into crew compartments to lay down a wetting spray. The truck can pump 150 gallons under 600-pound pressure in less than nine minutes.

PORTABLE AIRPLANE HANGARS, light enough to be carried to their sites in some of the planes that will use them, and as easily erected as a circus tent, are being made for use in combat zones and at remote strategic points. Set down complete with all building equipment, the parts can be put up quickly by unskilled labor and dismantled as readily for removal elsewhere as the occasion demands. Steel trusses supporting a flameproofed canvas roof and sides are in the form of three-hinged arches, to allow both for unevenness of the building site and for resiliency against explosions. All parts are so constructed that they can be nested in bundles weighing about 75 pounds to the linear foot, with no bundle over 19 feet long and none weighing over one ton. They are designed and made by the Butler Manufacturing Co., of Kansas City, Mo.

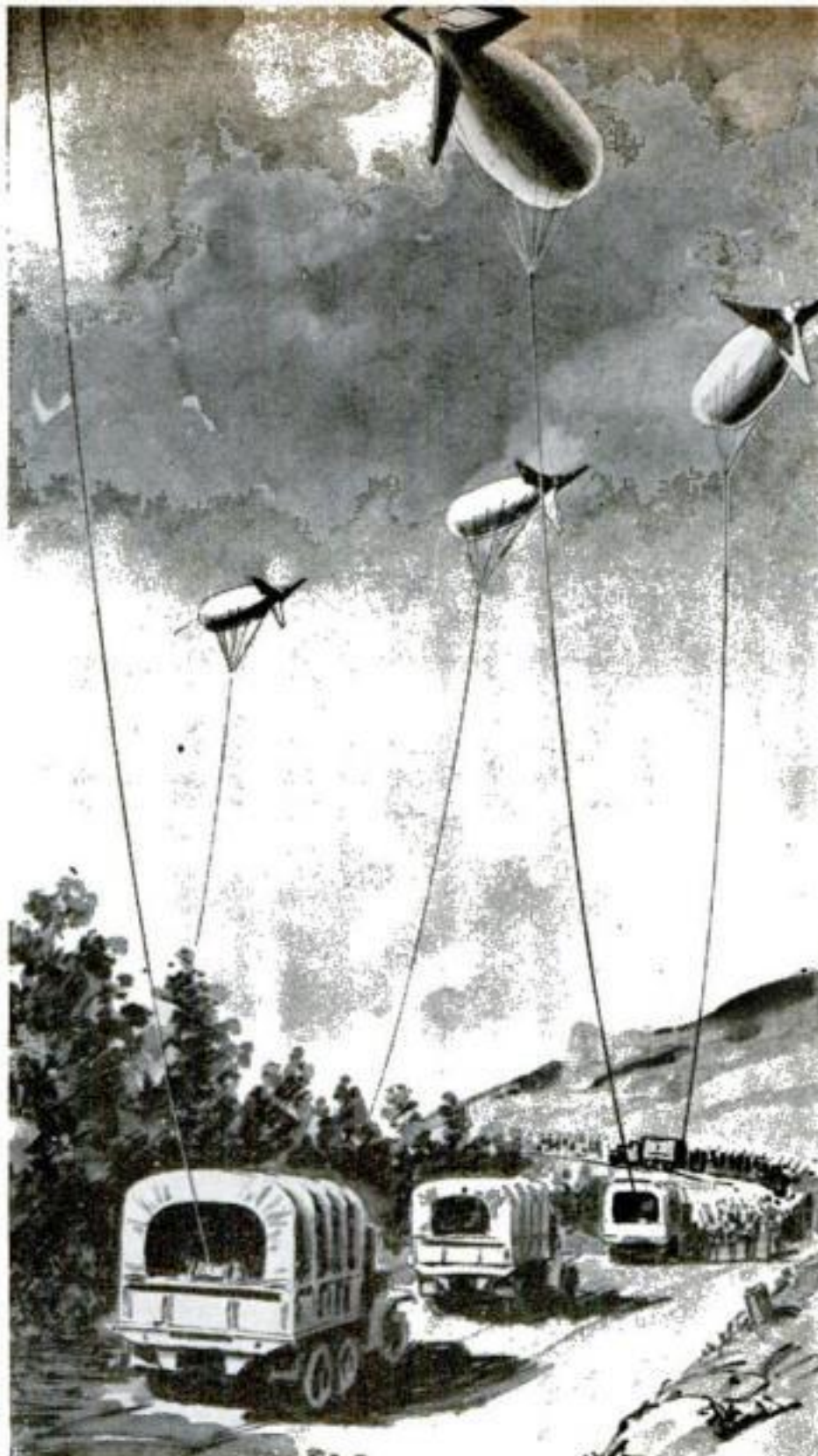


Truck-Towed Balloons

SHIELD TROOP CONVOYS WITH FENCES OF STEEL

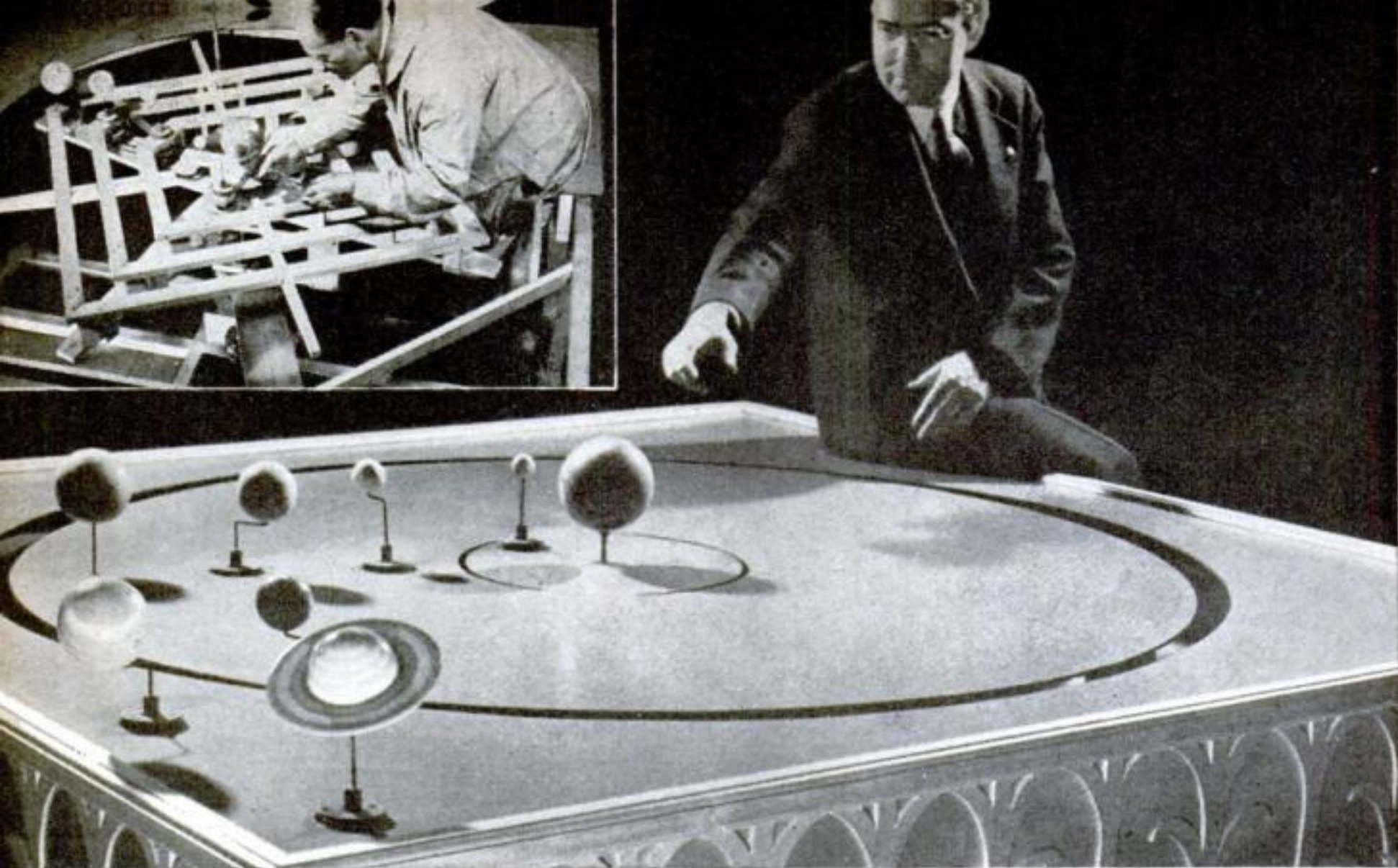
BABIES of the barrage-balloon family—tiny hydrogen-filled aerial “sausages”—now protect troop convoys from attack by low-flying enemy planes. Controlled by winches on trucks or on the ground, they hamstring attackers by lacing the air with steel cables. They are operated by VLA (very low altitude) barrage-balloon batteries. Easy to inflate and send aloft, they can be lowered nearly 200 feet a minute. The system has been used with success in several war zones. Strafers and bombers think twice before risking entanglement with the cables.

U. S. Army Signal Corps Photo



"VLA" balloons trailing behind trucks to keep enemy strafers away from a column of troops. These midget balloons are controlled by winches like that at the left. Below, crew members are adjusting stabilizers

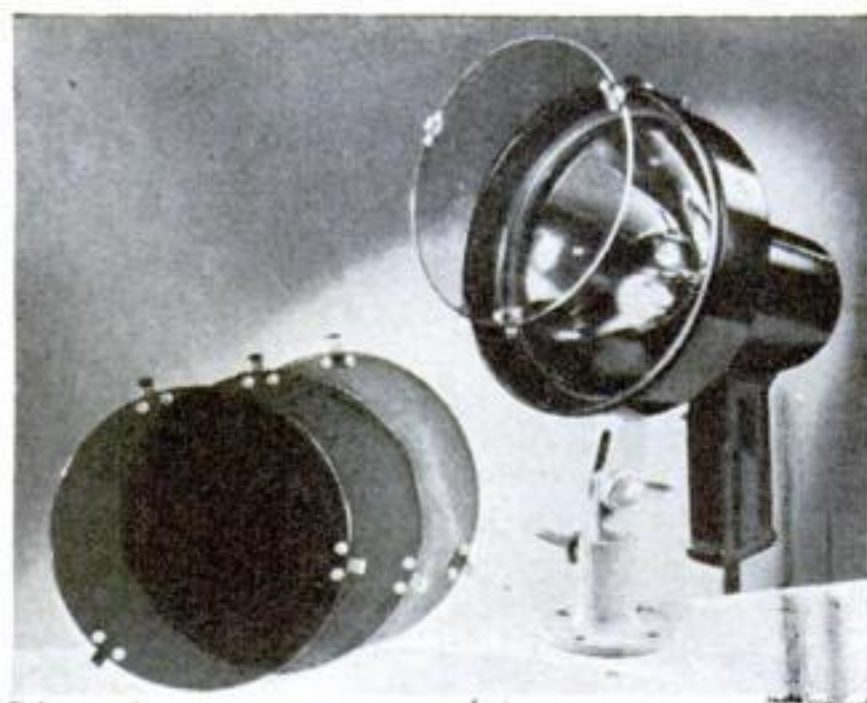
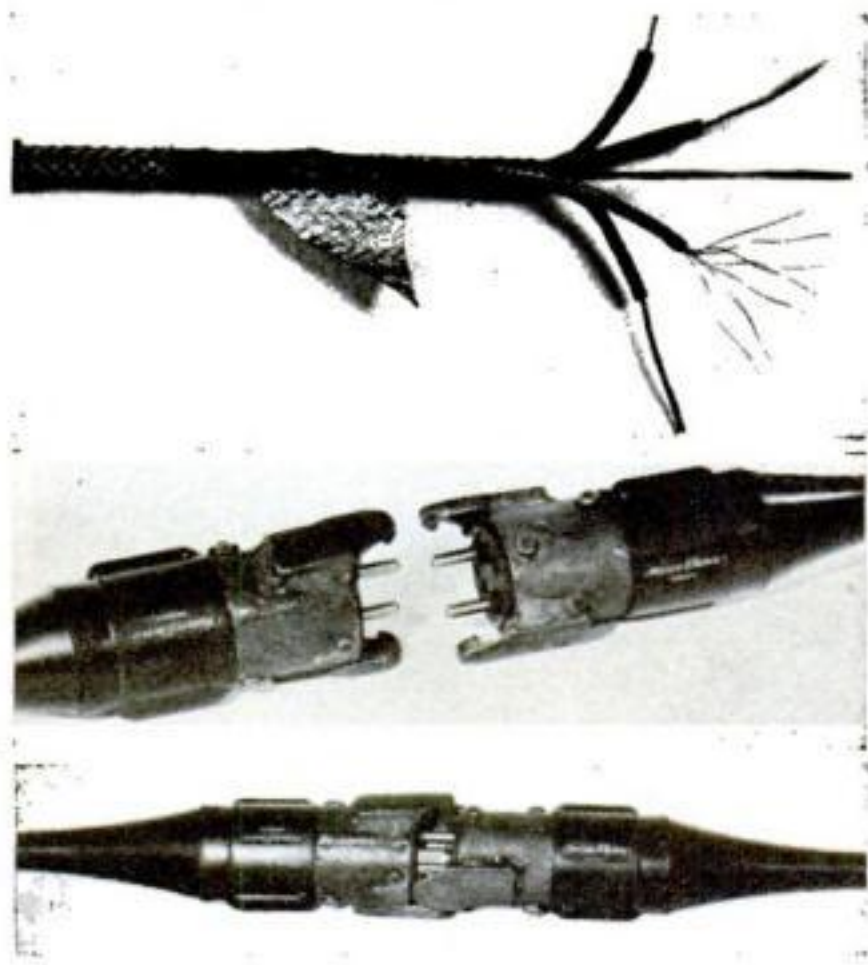




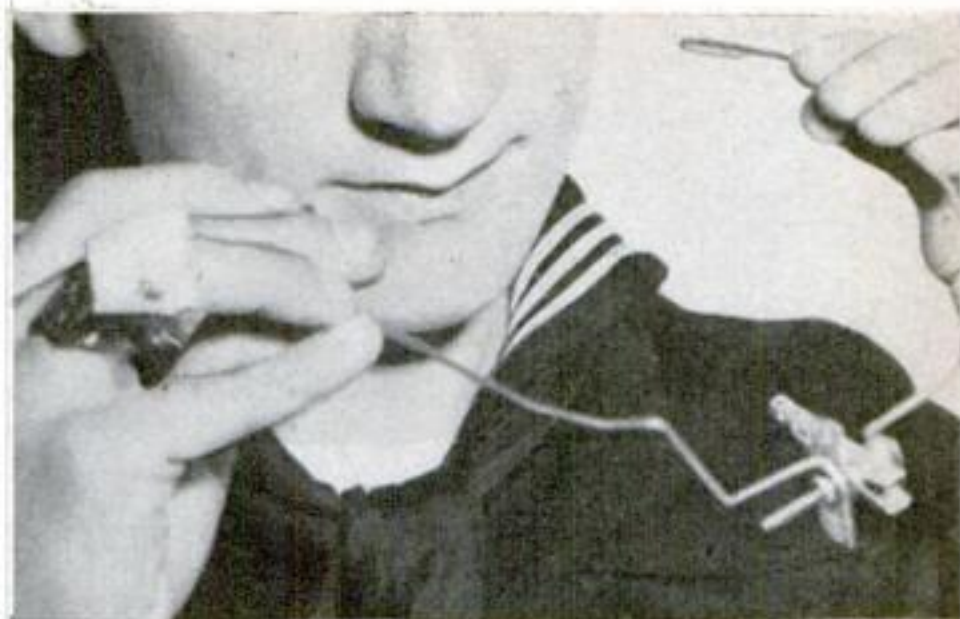
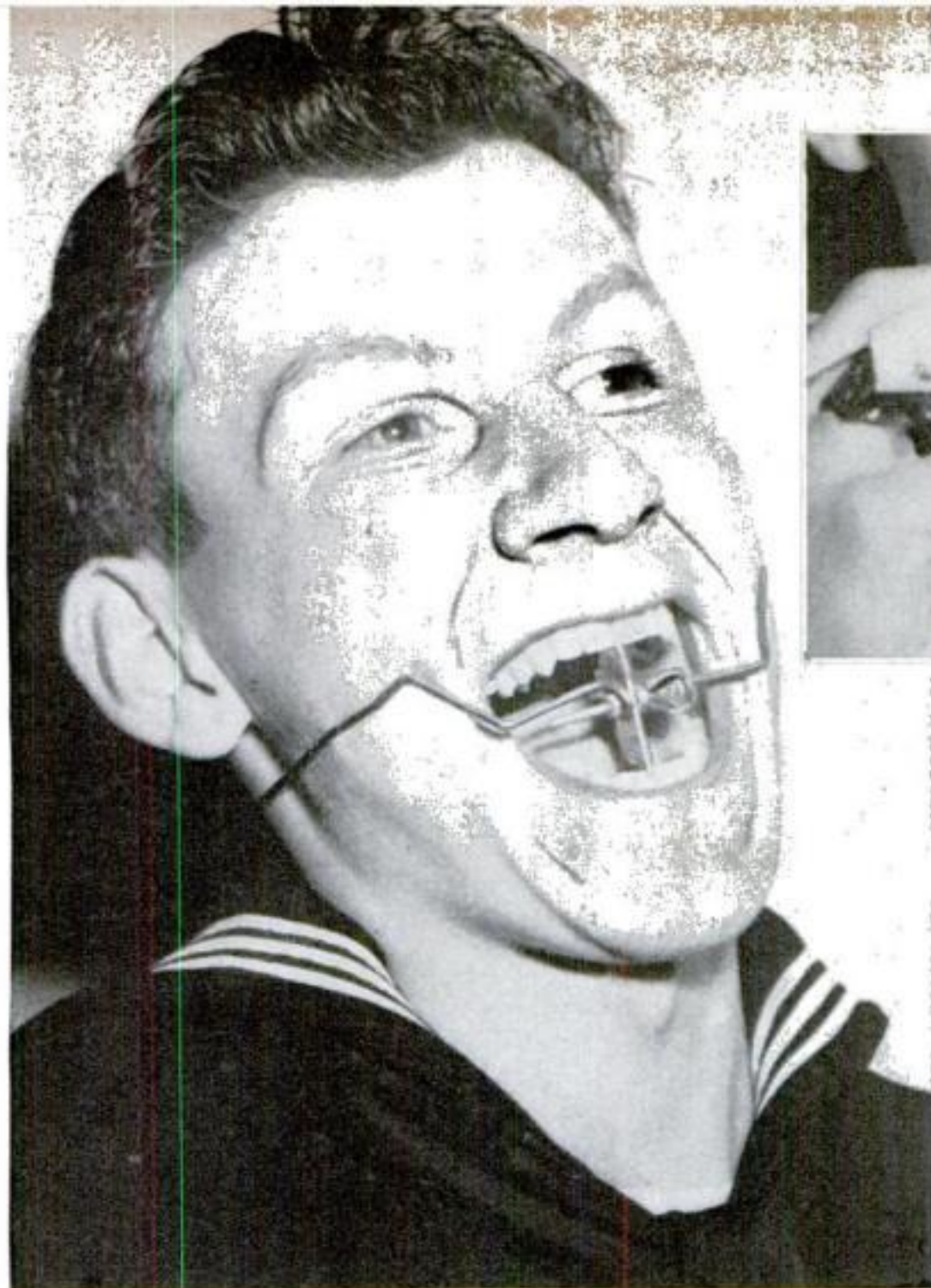
PTOLEMY'S UNIVERSE, in which the earth was the center of our solar system, has been reproduced in a model at the Hayden Planetarium in New York. Designed by Dr. William H. Barton, curator of the Planetarium, it provides means of contrast between this

ancient conception and the sun-centered Copernican system which supplanted it four centuries ago. On concentric turntables the moon and the planets rotate on their respective axes and revolve in their orbits around a stationary earth.

FOUR SPIRALING WIRES in a small cable (below) provide rapidly set-up communications to advancing battle fronts. Developed by the Western Electric Company and the Bell Telephone Laboratories for the Army Signal Corps, "Spiral-4" carries three telephone and four telegraph messages simultaneously over one set of conductors. Weatherproof connectors (also shown below), join sections of cable.

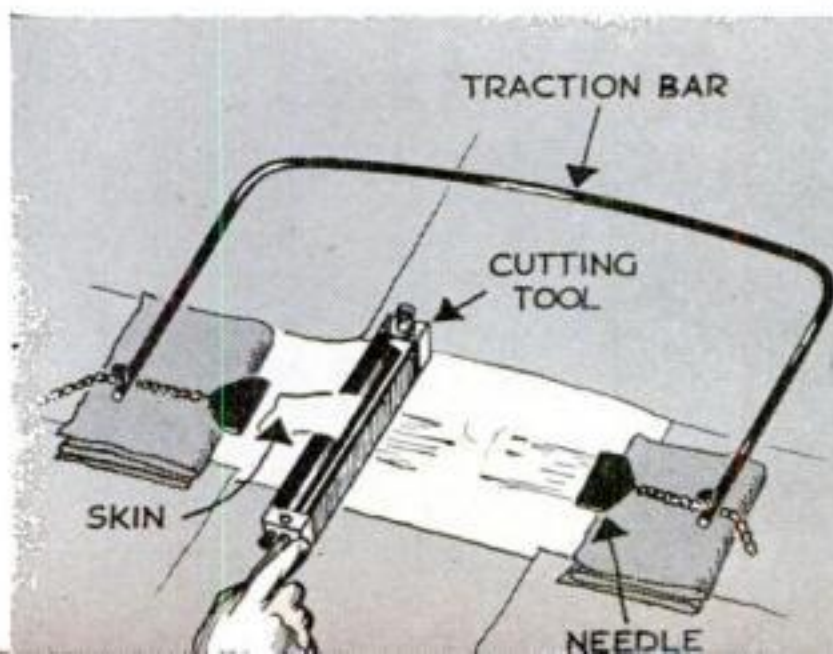


TALKING LIGHTS make possible good teamwork among fighting units when the use of radio is inadvisable. These signal lights for communication between plane and plane and tank and tank are being turned out at top speed by the Grimes Manufacturing Company in Urbana, Ohio. Light in weight, durable, adequately insulated from heat, and resistant to wear and abrasion, the lights are manufactured with an economy of strategic metals. The plastic housings are made of Bakelite phenolic molding material, and the many-colored lenses, shown beside the lamp in the photograph above, are of Bakelite polystyrene. A pistol grip and trigger make it easy to aim and operate the light.

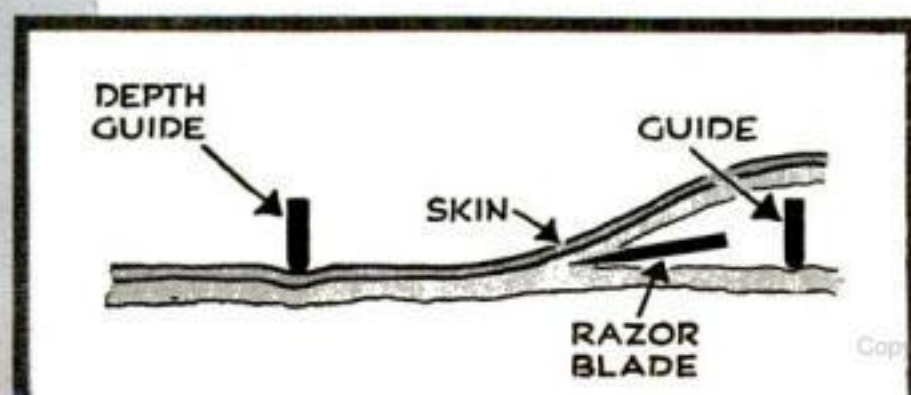


A TONGUE HOLDER, to replace the time-honored nail or safety pin for securing the tongue of a submersion victim while he is being given artificial respiration, has been devised by Thomas J. Arthur, seaman second class at the U. S. Coast Guard's Manhattan Beach Training Station. It consists of two copper wires and a head strap, with a rubber-lined brace that holds the tongue so that the subject cannot swallow it. Seaman Arthur has been commended for his initiative.

SKIN GRAFTING, to prevent disfiguring scars as a result of burns received in combat, can be performed easily under field conditions with a simple surgical knife invented by Dr. Edgar J. Poth, associate professor of surgery at the University of Texas, in Galveston. It allows surgeons to take skin of any desired thickness from one area of the body for grafting on another. The device consists of a holder carrying four safety-razor blades, a frame which holds this cutting edge and regulates the depth of cut, needle retractors for the skin, and a traction bar which holds the skin taut. Grafts are mounted on gauze and transferred to the wound. Dr. Poth's invention supplements standard surgical instruments such as the Padgett Dermatome seen in use at right.



Removing live skin from a patient with the Padgett Dermatome, for grafting on a burn. Dr. Edgar J. Poth's simple invention for performing the same work in the field is illustrated in drawings at left and below



Can We Fly at

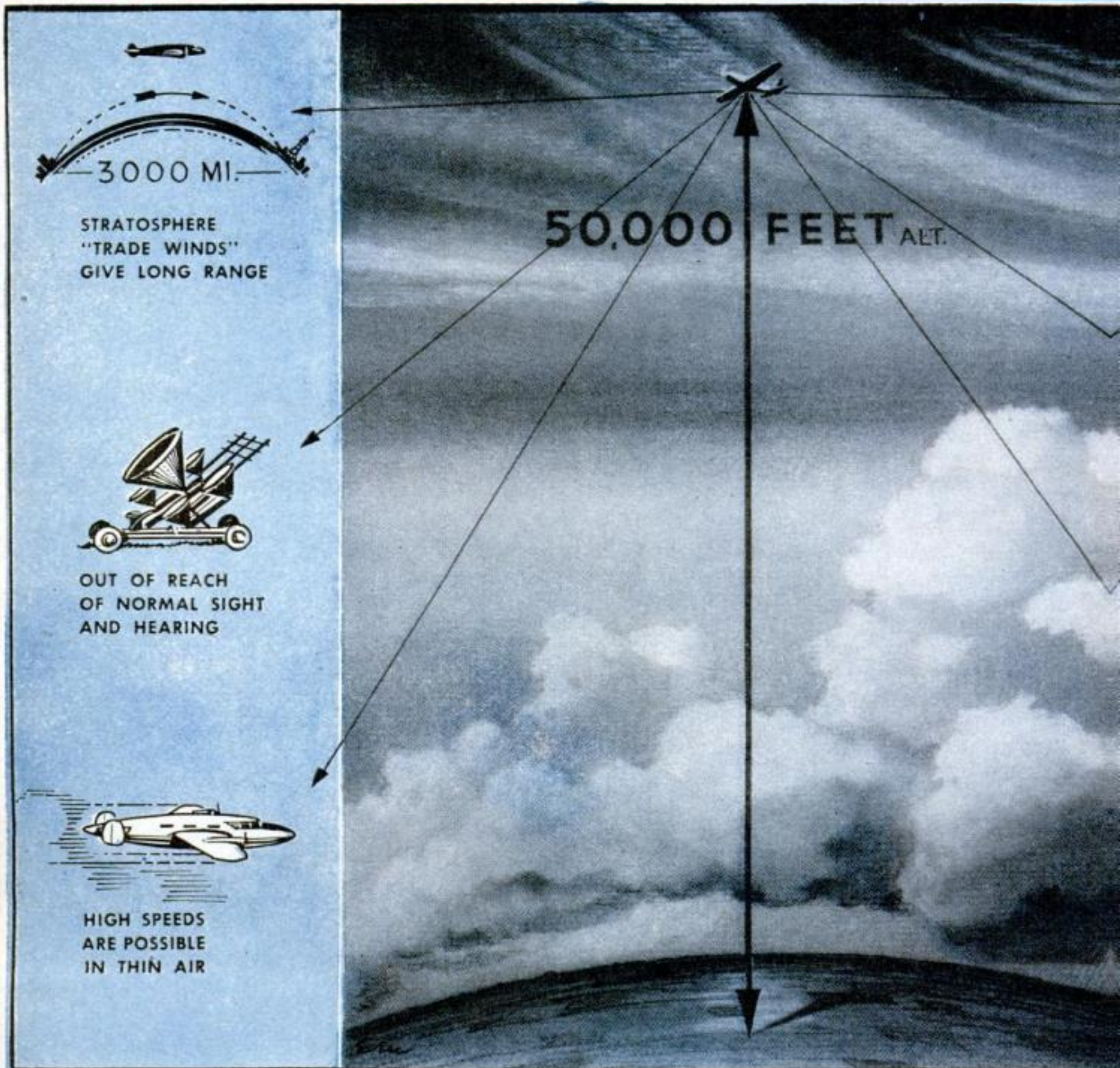
Dragging his planes to ever higher levels, man encounters deadly enemies in cold and low air pressure. . . . Can science conquer the stratosphere?

By
WILLIAM S. FRIEDMAN

MODERN military air operation has established certain advantages for high-level flying. The first, of course, is virtual immunity from anti-aircraft fire. Another is freedom from interception, because the higher the airplane flies, the greater the time lapse before intercepting aircraft can climb to the level of the high-flying ship.

At 40,000 feet, the true air speed of a ship is twice that of the same ship at sea level; the upper winds are steady and reliable, and, once charted, can be depended on, month in and month out, to be there as an

WHAT ARE THE ADVANTAGES OF FLIGHT IN THE



50,000 Feet?

aid to operation. Furthermore, because virtually all the weather phenomena occur in the troposphere, or lower level of the air, conditions in the upper levels are constant and reliable.

For the same reasons, many long-visioned planners of postwar air lines are looking forward to the development of high-altitude equipment for long-range travel in the days ahead.

The 50,000-foot level, from an operational viewpoint, looks like an attractive place to fly. The weather is, for all practical pur-

poses, constant, varying only a little with latitude. Above the level beginning at around 36,000 feet, the air is perfectly dry; the temperature is almost constant at -55 degrees C. (-67 F.). The barometer, which normally stands at 760 mm. of mercury on the ground at sea level, reads 87.30 mm. at 50,000 feet—or .1518 the weight of normal air.

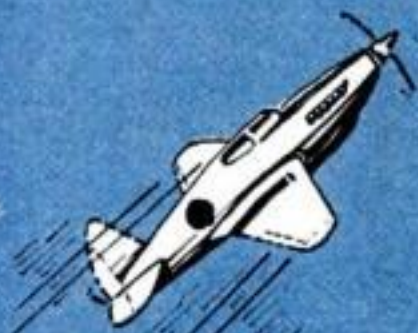
Man and his flying machine are intruders at that altitude, and nature treats them as such. The machine must carry heavy and cumbersome equipment to supply its engine with enough air to burn fuel needed to stay on the wing. Man himself is like the proverbial "fish out of water," and must surround himself with as close to a synthesis of ground conditions as possible in order merely to stay alive.

When man was satisfied to call 20,000 feet high altitude, his problems

STRATOSPHERE?



VIRTUALLY IMMUNE
TO ANTI-AIRCRAFT
FIRE FROM GROUND



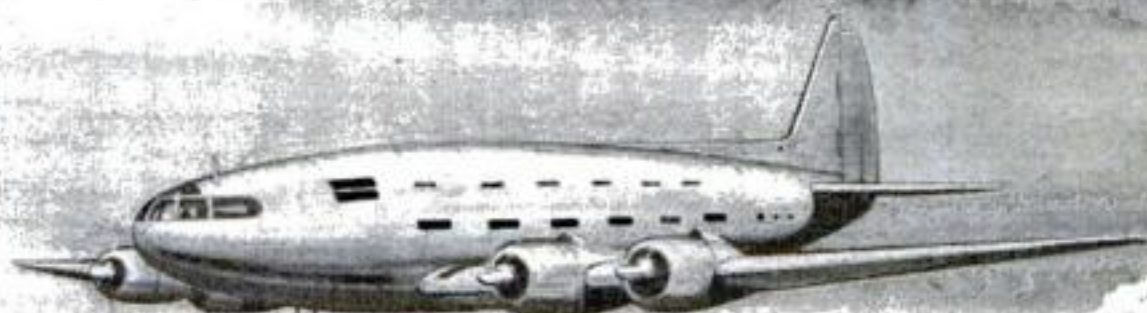
TOO HIGH FOR
ATTACK BY
INTERCEPTORS



ABOVE LEVEL
OF WEATHER
DISTURBANCES

For both military and commercial flying, the 50,000-foot level offers many operational advantages. However, serious obstacles are presented by low atmospheric pressure, thin air, and extreme cold

...AND WHAT ARE ITS PROBLEMS?



RUBBER BECOMES BRITTLE
AS GLASS. HYDRAULIC FLUID
GETS GUMMY AND THICK



OIL HARDENS TO THE
CONSISTENCY OF TAR.
GREASE HARDENS, FLAKES



NECESSARY INTERCOOLERS,
AFTERCOOLERS, AIR DUCTS,
SUPERCHARGERS ADD WEIGHT



OXYGEN TANKS, PIPE LINES,
DIALS, AND REGULATORS
FREEZE, ICE UP FROM BREATH



ENGINEERS ARE BUSILY SEEKING THE ANSWERS



Consolidated test engineers install "Celstrain" gauges in an experimental enclosure to detect bulges, twists, and ripples under pressure



Westinghouse research chemist Howard M. Elsey tests generator brushes to carry heavy loads at high altitudes



A "deflection pantograph" measures tiny changes of contour in window glass for pressurized cabins



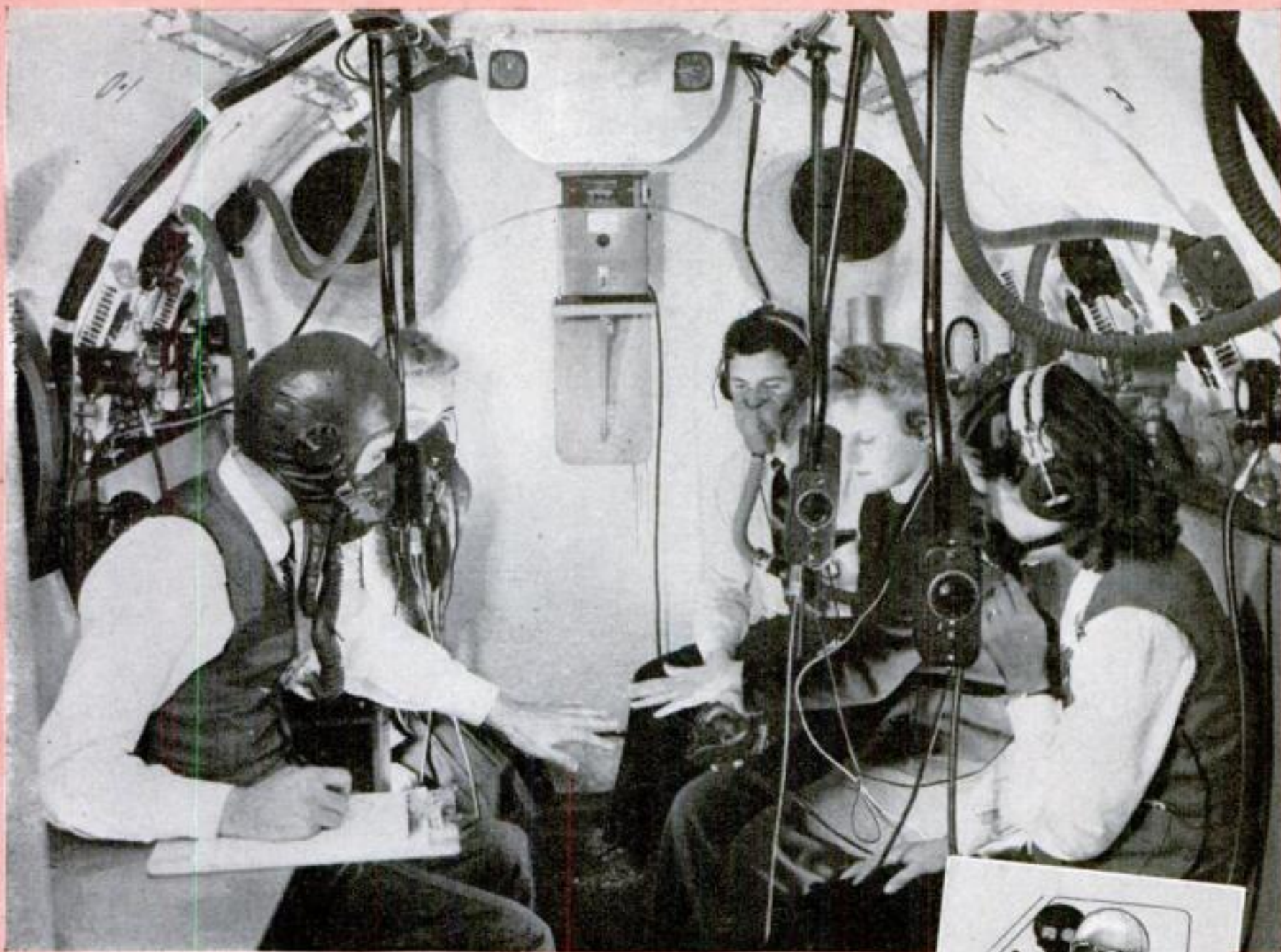
With an instrument called a "Strobotac," the vibration modes of a plastic wing tip are analyzed

were comparatively simple. Warm clothing solved the problems of adequate body heat; bottled oxygen solved his air problems. The major questions were mechanical—getting the engine to produce enough power to keep the airplane in flight in the thinned-out air.

Both man and motor suffer from reduced

air pressure. The motor is given more oxygen by feeding it forced air (supercharging); man is supercharged by his oxygen equipment. As the ship sought more altitude and the application of superior supercharging made higher ceilings possible, both man and the airplane were beset by a multi-

TO PROBLEMS THAT PUT A CEILING ON FLIGHT



Conditions of stratosphere flight are reproduced at ground level in high-altitude test chambers, to show reactions of men and machines



tude of problems stemming from the decrease in temperature and pressure.

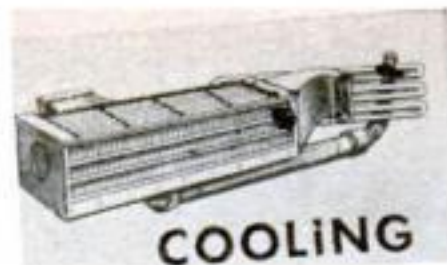
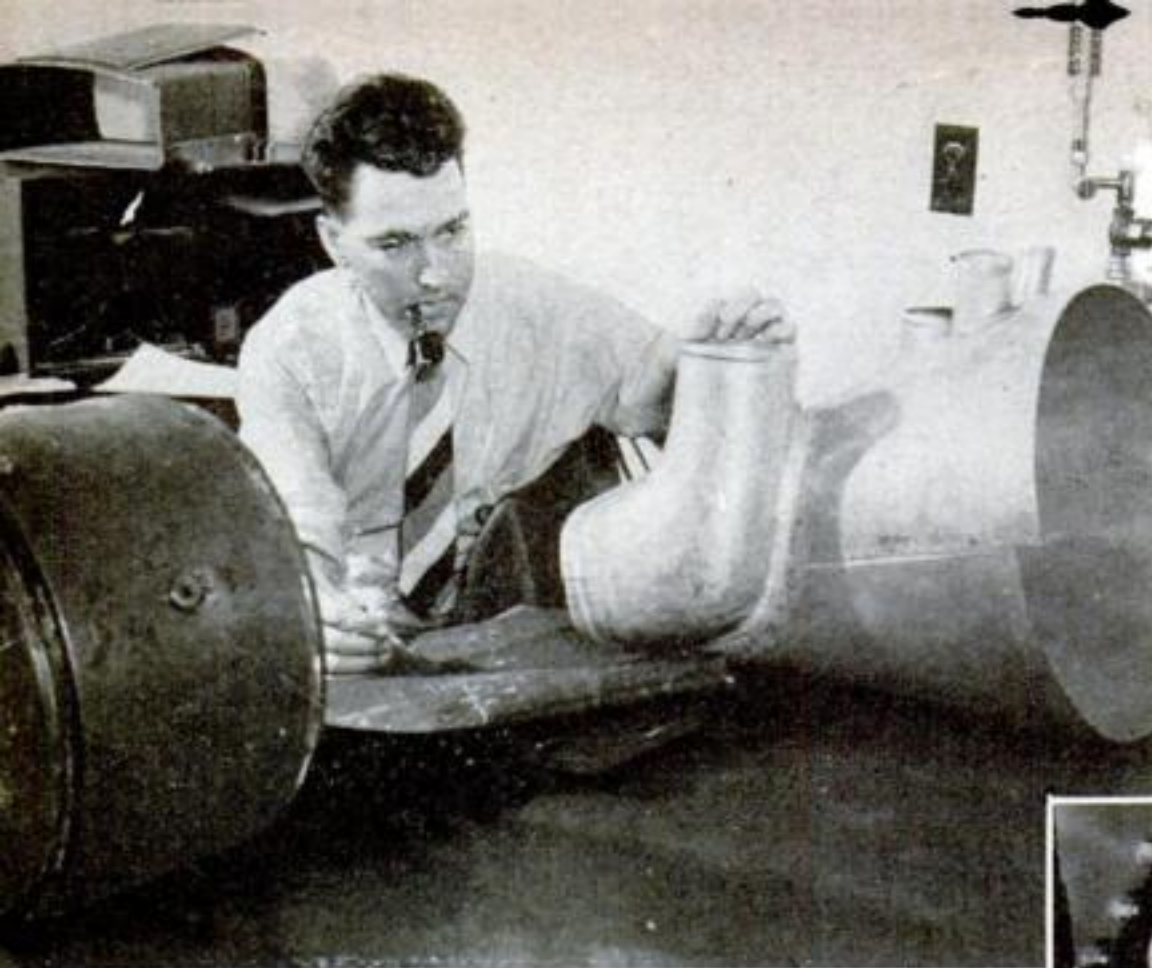
By the time a human being reached 50,000 feet, if he were unprotected against the elements he would have been subjected to the most excruciating pains a man can know, finally to die—no matter how much bottled oxygen he inhaled.

The pain would be caused by the expansion of gases in the body. Gases in the major physical cavities have normal channels for expulsion, but particles of dissolved gases that lodge in fat tissues and in the joints expand as the outside pressure decreases, and the pain is more severe than that of rheumatism. The gas in your stomach at 35,000 feet will expand five times!

Long before water reaches the boiling temperature, the dissolved gases are expelled. The higher the altitude, the lower the boiling point. At the same time, many of the body fluids are less dense than water and have a much lower boiling point. By the same token, these liquids would surrender their dissolved gases at a much lower temperature. The temperature of the human body, however, is substantially constant



Lubricants become sluggish in subarctic cold. Here an engineer determines the viscosity of a sample of oil



COOLING

Air ducts and cooling equipment must be designed for lightness and strength. Below, a "puffer" tests a cabin seam seal for leaks

(98.6 degrees F.). The increase in altitude brings the gas-expelling level of these fluids and the body temperature into dangerously close proximity.

Before the war began, Transcontinental and Western Air, Inc., put into service the Boeing Stratoliner, a high-altitude, over-weather ship which incorporated a sealed and pressurized cabin which would retain troposphere pressure conditions at high levels, permitting ordinary flight comfort at high altitudes. This ship was not for stratosphere flight, but flew the substratosphere and decreased altitude effects by about 8,000 feet when operating at its top level.

The first problem to be solved in the business of high flight was that of engine supercharging. Naturally, when one left the greater part of the atmosphere below, the engine would feel the effects of oxygen starvation long before the pilot. Superchargers are simply rotary compression pumps that provide sea-level air to the engine at higher altitudes. Dr. Sanford Moss gave mankind the key to stratosphere flying when he designed the exhaust-driven turbo-supercharger toward the end of the last war. However, it opened the way for a multitude of subsidiary problems. For instance, the heat resulting from extra compression necessary at extreme altitudes is so great that special cooling apparatus must be used to reduce temperature. These "intercoolers" and "aftercoolers" used with high-altitude supercharger equipment add to weight, bulk, and complication.

The coefficient of expansion of aluminum is about twice that of steel. At ordinary temperatures, this difference would be too small to warrant serious consideration. However, when the temperature drops to -67 degrees F., the tiny difference mounts. Multiplied by the 67-foot length of the typical four-engine transport's fuselage, the



difference is manifested in the slacking of control cables. Particularly at high altitudes, this lost motion can be dangerous.

The first step in solving this problem was the installation of a tension gauge on control lines, so that adjustments could be made manually. Currently, research is being conducted to determine what method—springs, hydraulic cylinders, etc.—would adequately take up this free play without giving the pilot another detail to worry about in the stratosphere.

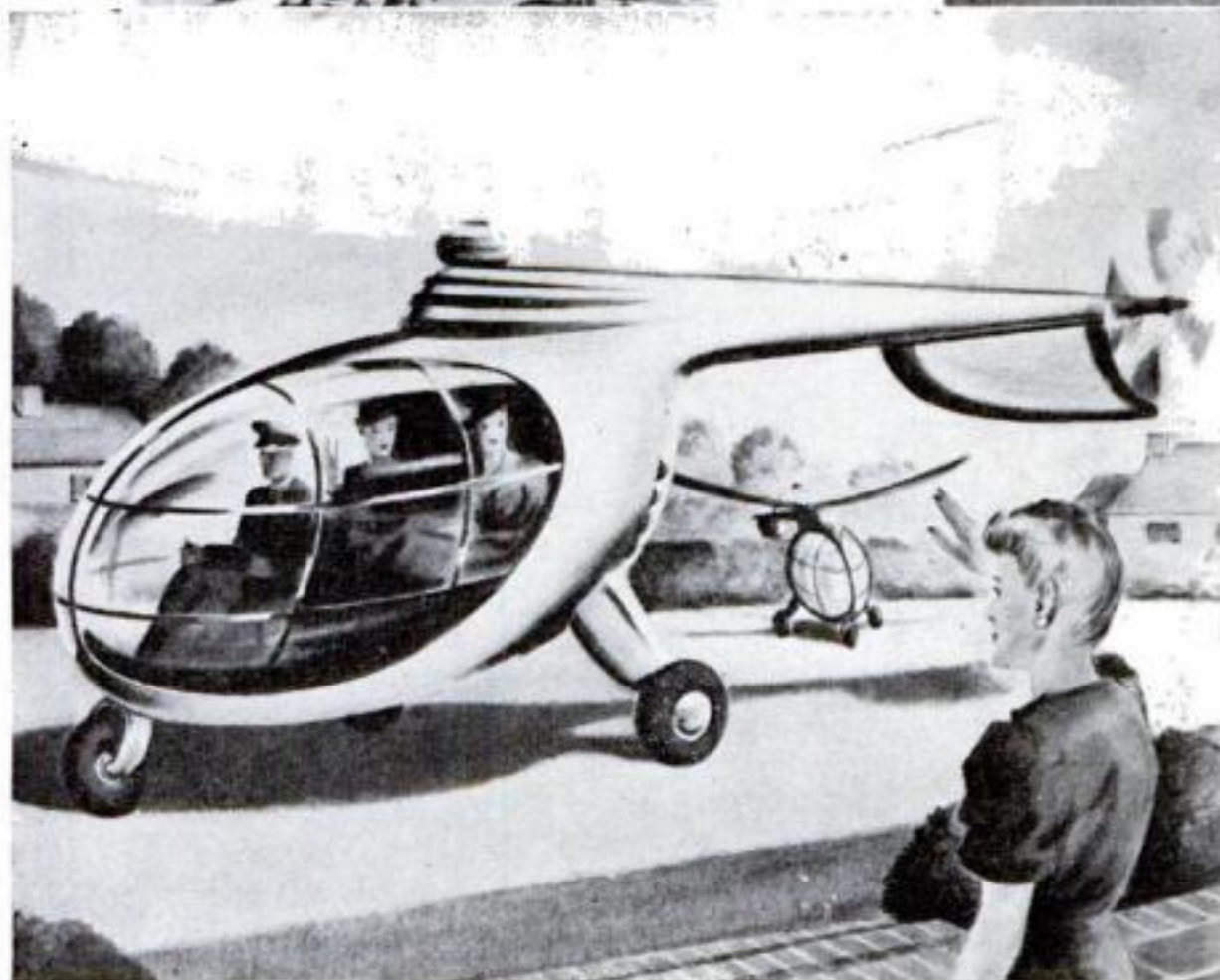
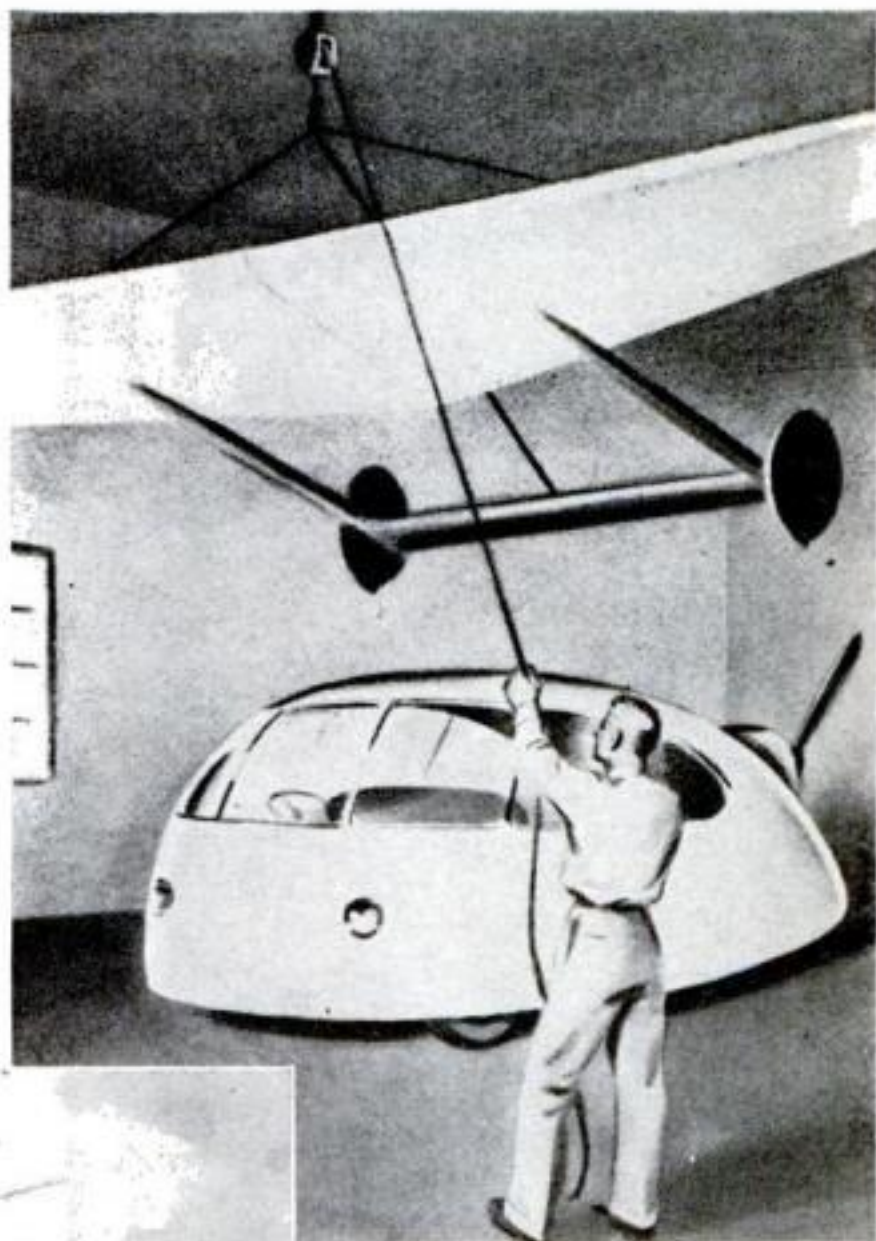
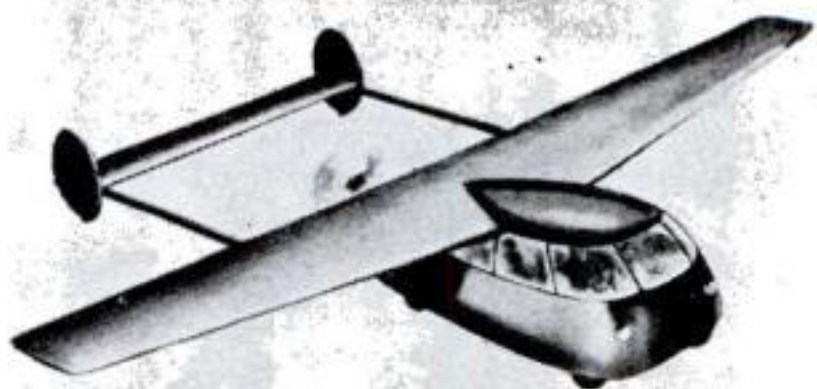
The stratosphere itself should be its own best research laboratory. In theory, the best way to find out whether something will work at 40,000 or 50,000 feet is to take it up there and find out. That is the way the earliest pioneers tried it, and the experimental trail is littered with their bones.

A recent example of this realistic testing was the parachute jump from 40,200 feet made by Lieut. Col. William Randolph Lovelace near Euphrata, Wash., on June 24. The 35-year-old chief of the Aero-Medical Laboratory at Wright Field, Dayton, Ohio, wanted to make a personal test of bail-out oxygen equipment for high altitudes developed under his supervision. Although he had never jumped (*Continued on page 212*)

Your Postwar Plane

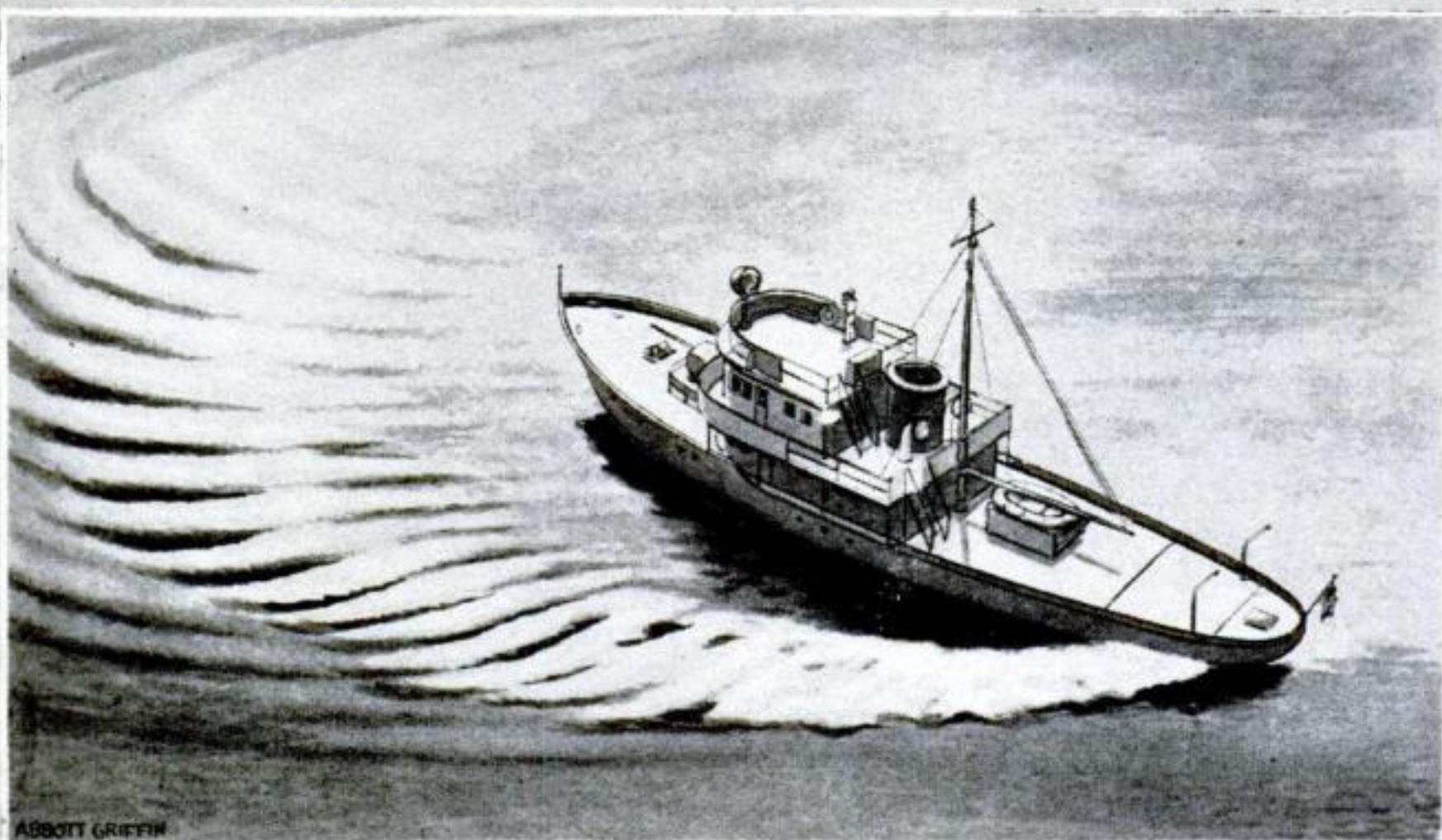
ALREADY in the laboratory stage of development, three models of postwar planes for private flyers are proposed by William B. Stout, famed designer who now heads the Stout Research Division of the Consolidated Vultee Aircraft Corporation. For use in congested city areas, an improved helicopter that he calls a "Helicab," capable of landing on a flat roof, reduces a commuter's travel

time. An "Aerocar," intended primarily as a family automobile, employs four wheels on the ground. For week-end flying trips, it dons wings in your garage and skims through the air at 100 miles an hour. Suitable for covering longer distances, a light "Roadable Plane" travels mostly by air but can fold its wings for shorter ground trips. Mass production of the new types, Stout foresees, will keep present warplane factories busy; and the maintenance end of private flying will provide jobs for 500,000 men now under arms.



This is William B. Stout's idea of a postwar motorist getting ready for a week-end jaunt by air. A wing and outrigger assembly kept in the garage would convert the "Aerocar" into the plane pictured at upper left

A lawn or a tennis court is all the landing field required by the "Aerocab," Stout's design for an improved helicopter for family use. It could rise vertically, fly sideways or back, and hover stationary in the air



A ship makes a complete turn with forward motion stopped. Drawing was made from an actual photograph

Turning a Ship

PROPELLER DOUBLES AS RUDDER, SPINNING VESSEL AROUND

SHIPS that can spin in a circle while at a dead stop, move sideways to dock at a pier, and perform equally unconventional evolutions, are made available to American designers with seizure of an enemy alien's propeller patent by the Alien Property Custodian. Navy and Maritime Commission officials recently attended a motion-picture demonstration at Washington, D. C., showing how the remarkable mechanism might be adapted to war purposes.

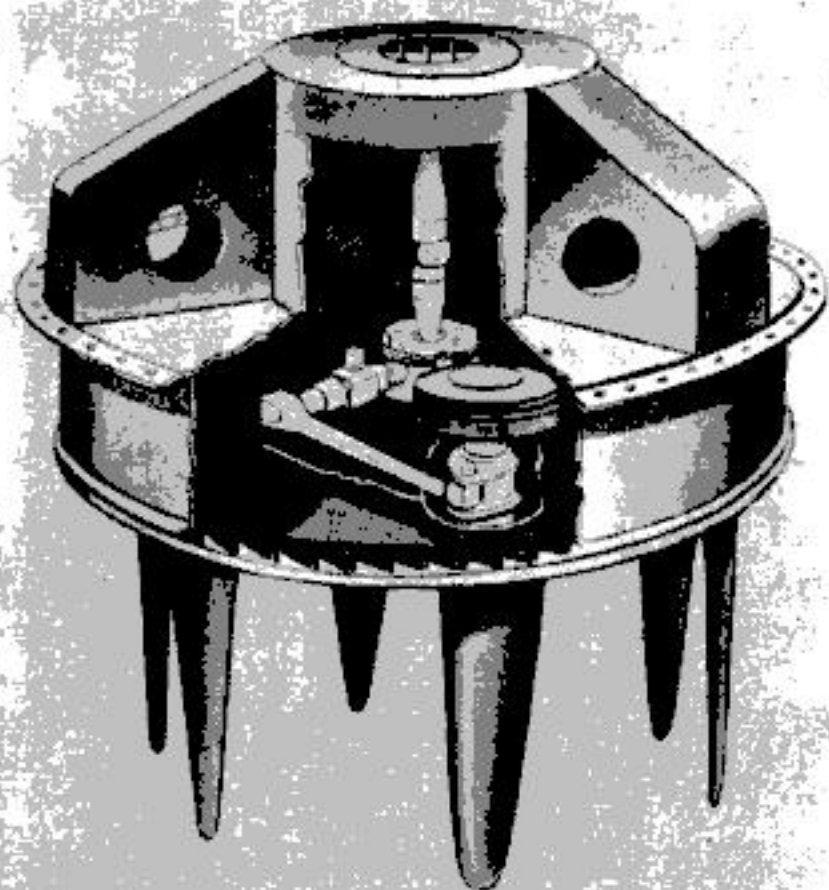
As long ago as 1926, the Austrian inventor, E. Schneider, turned over to a German firm the rights to develop the propeller. One of the first practical tests was made with a small motorboat (P.S.M., Jan. '32, p. 47). Since then, improved installations ranging from 100 to 4,000 horsepower have been made in vessels up to 300 feet in length—including, it is reported, more than 50 German warships.

In appearance, a propeller unit resembles a circular washtub, with a rotating base bearing four or more vertical paddles about its rim. Each paddle, curved like a section of an airplane wing, has a separate oscillating action. In making a complete revolution, the paddles all exert a maximum force

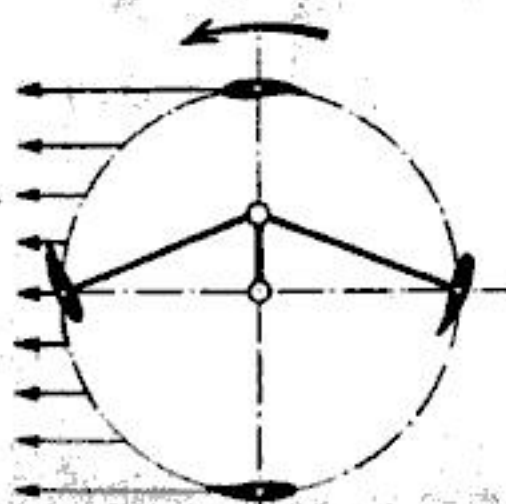
in one direction, which is astern for forward propulsion.

At this point the last resemblance to a standard propeller ends. No rudder is needed to steer the ship, no control to vary its speed or to reverse it. All these functions are performed by altering the angles of the blades themselves. A light touch on a steering wheel and another on a throttle operate two servomotors in the propeller unit. Mounted at right angles to each other, the servomotors impart a universal motion to a tilting control stick which, through an eccentric disk and a sort of spider-web linkage, sets the blades as desired.

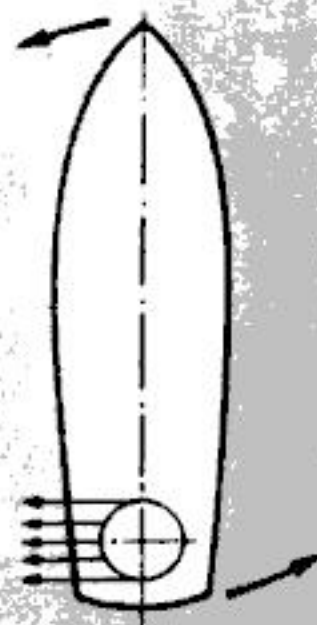
Sideways motion of the control stick drives the ship ahead or in reverse; the "bite" of the propeller blades, and therefore the speed, increases with the distance from the center. Fore-and-aft displacement of the stick from its central or "idling" position turns the thrust of the propeller sideways and spins the boat. By combining the two motions, all possible combinations of turns while moving forward or in reverse may be performed. The new propeller system would afford greater maneuverability for PT boats, destroyers, and other craft.



Vertical fins, revolving with the base of the new propeller unit, replace the conventional blades. The linkage shown in the cut-away section oscillates the fins to give thrust in any direction, depending on the way the control rod is tilted

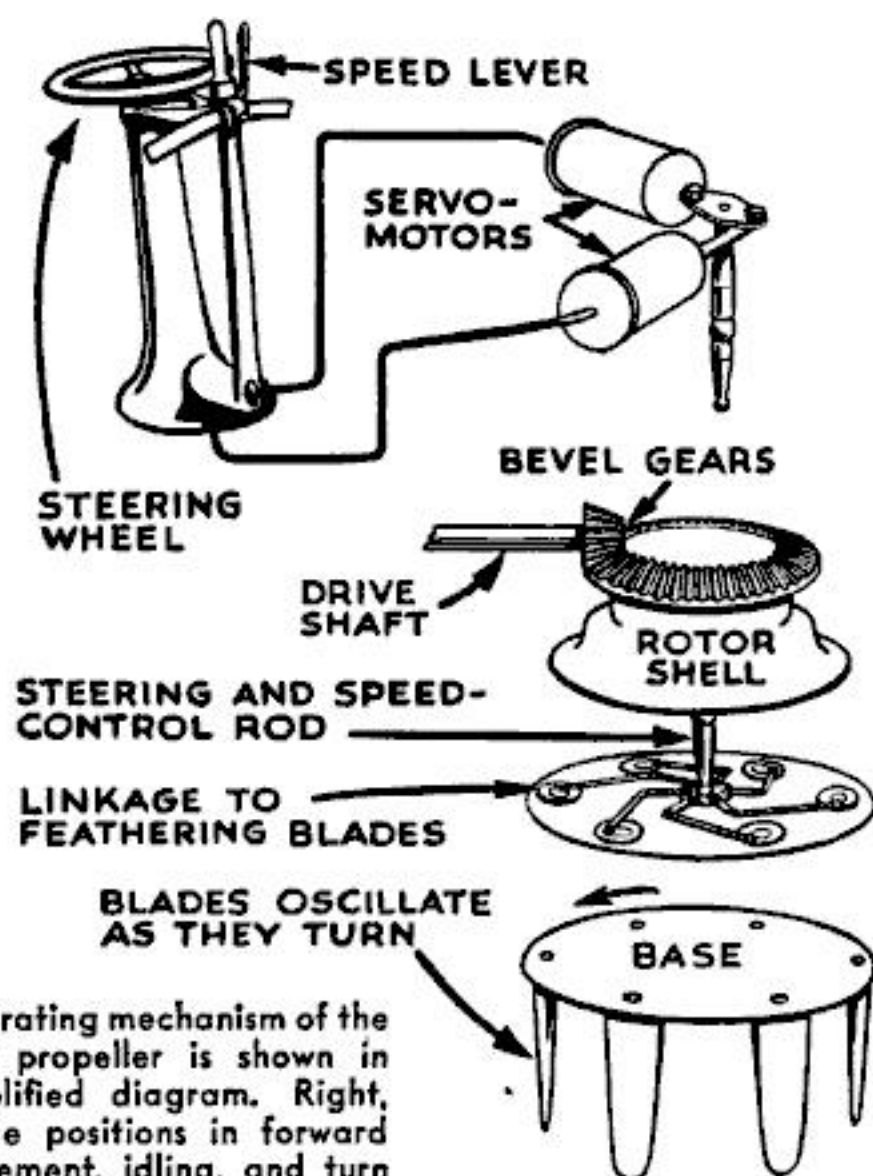


Position of control rods and blades for executing the remarkable maneuver pictured on the opposite page. The sideward thrust of the propeller pushes the stern in the opposite direction, as at the right

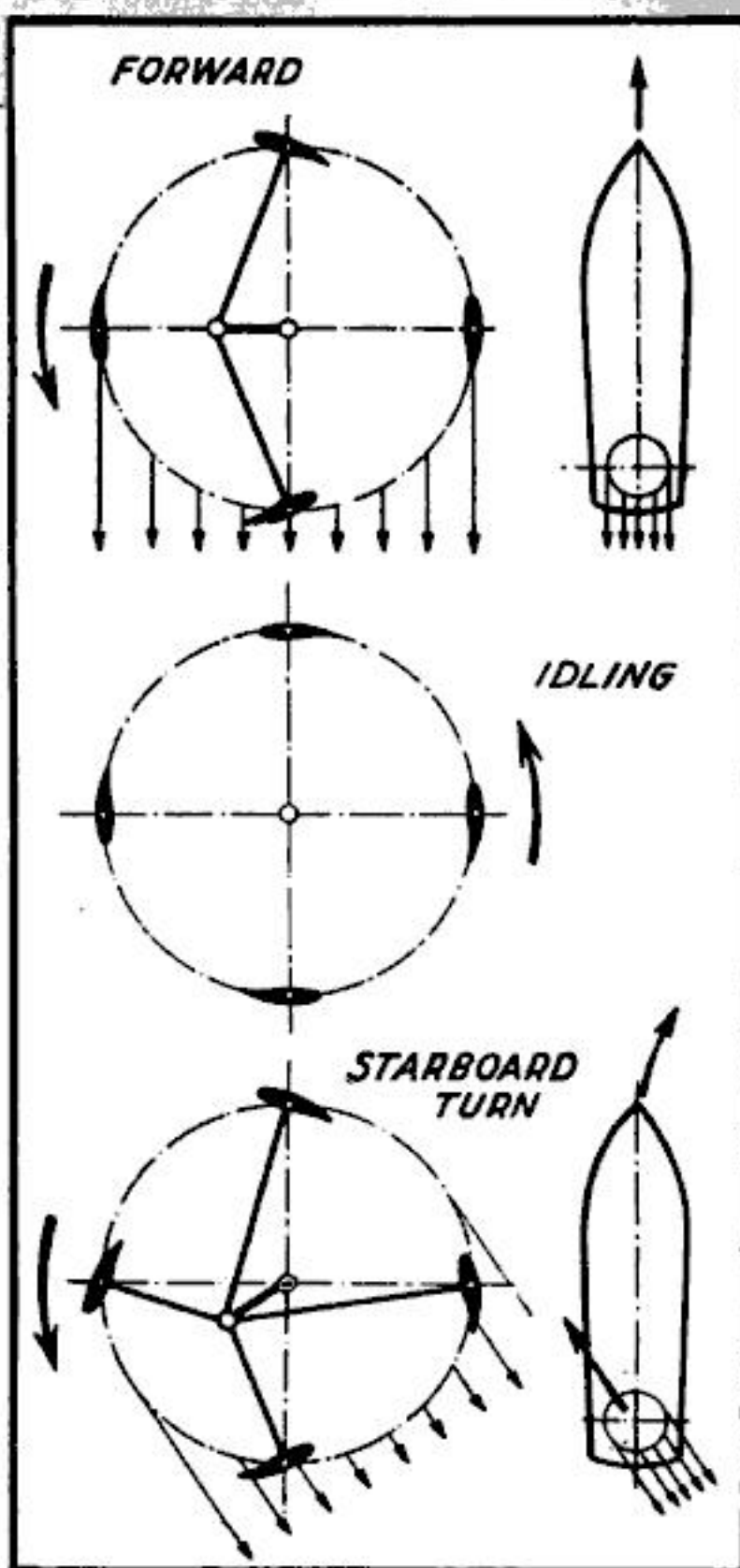


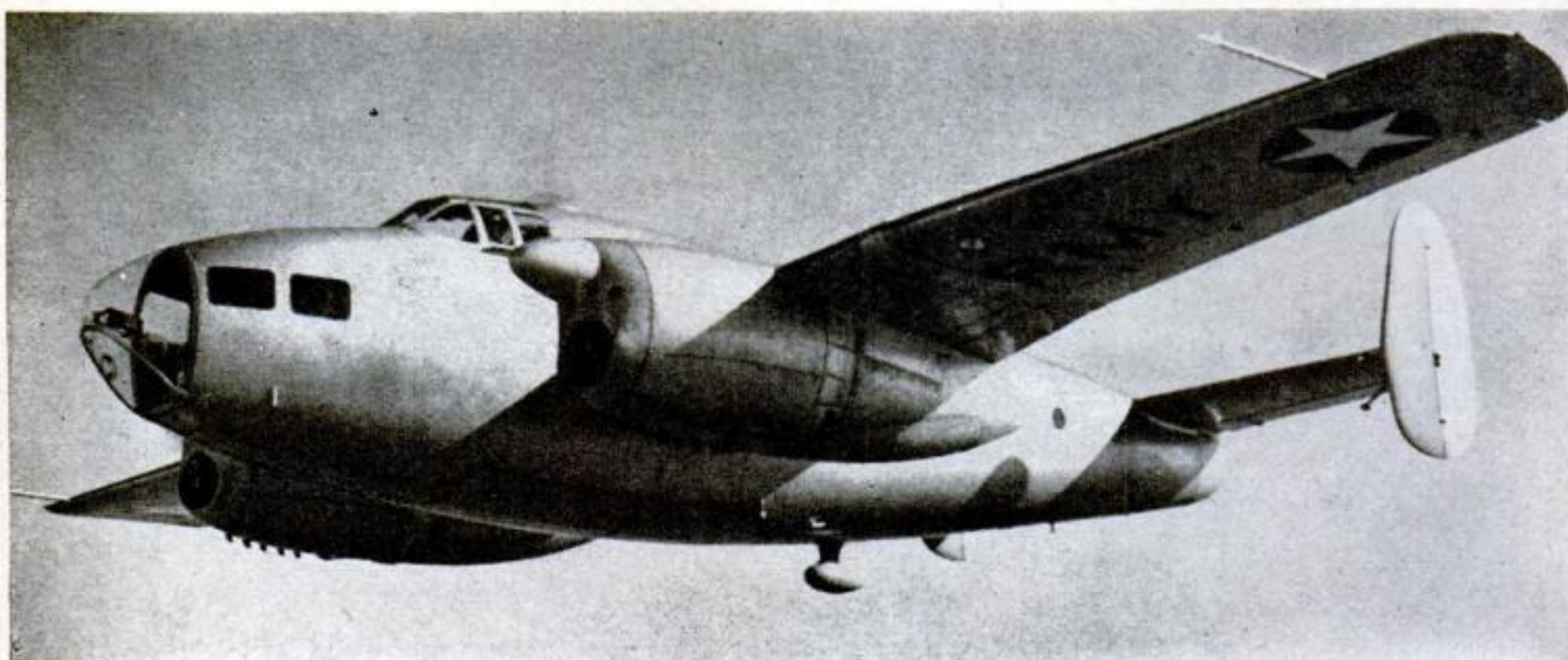
on a Dime

OR MOVING IT SIDEWAYS



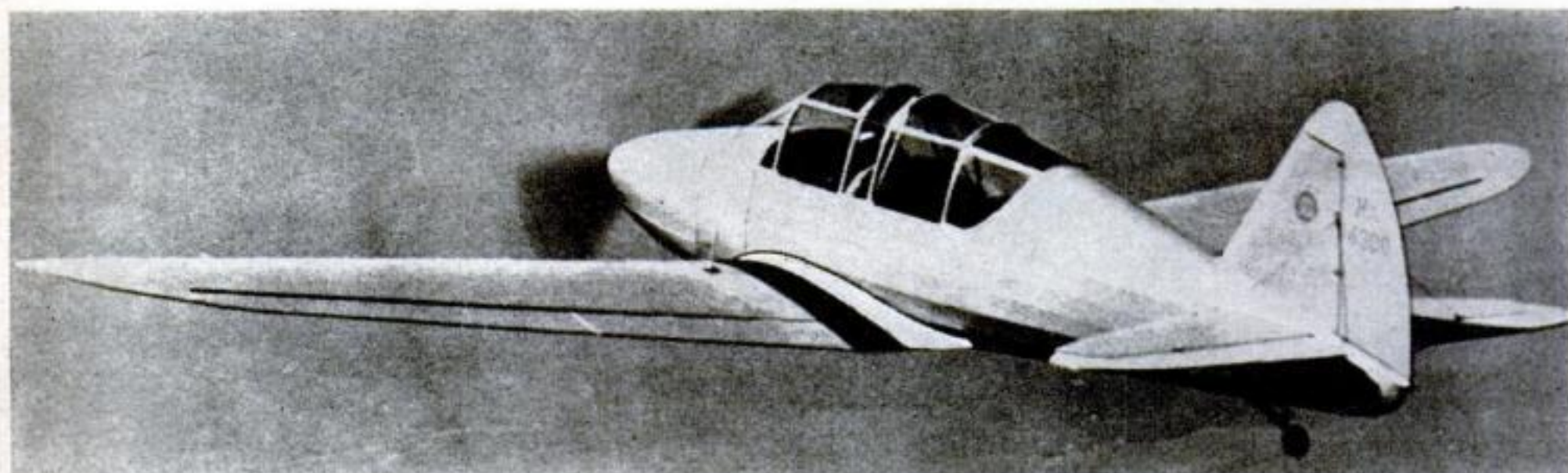
Operating mechanism of the new propeller is shown in simplified diagram. Right, blade positions in forward movement, idling, and turn



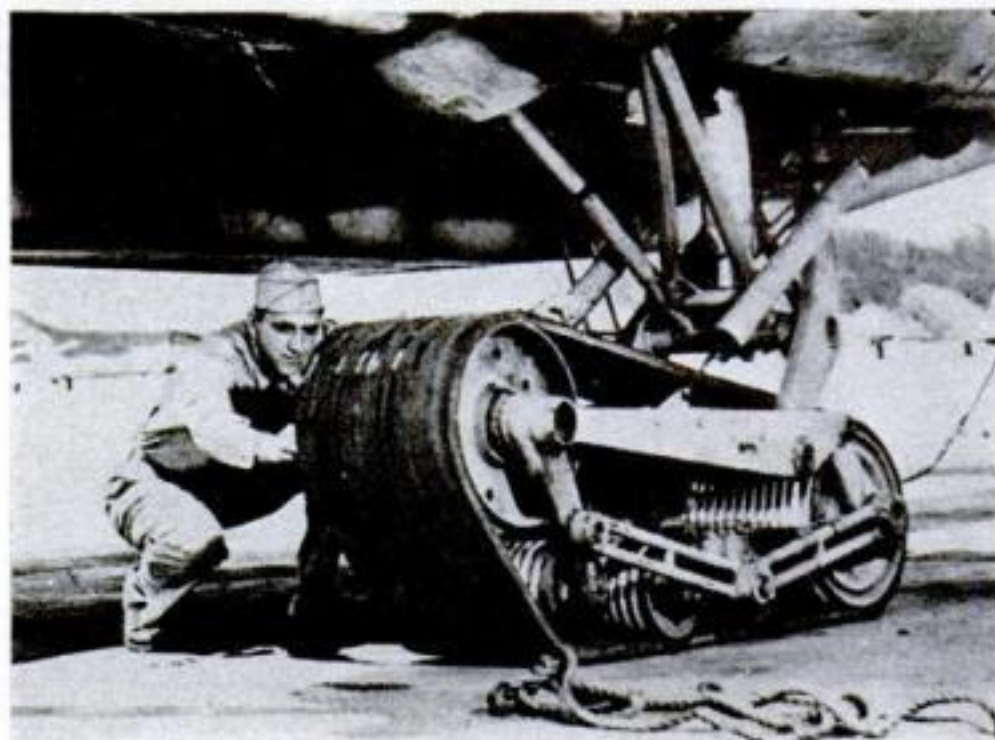


AERIAL GUNNERS get advanced training in the AT-21, built by Fairchild Aircraft at Burlington, N. C. Made of Duramold processed plastic-bonded plywood, this adaptation of the AT-13 and the AT-14 has special structural innovations for gunner training

PRIMARY TRAINER. Safe and easy to handle, but as swift and maneuverable as more advanced trainers, the new PT-1, product of Piper Aircraft, Lock Haven, Pa., is adapted for transitional pilot training. Shown below, it has NACA slotted flaps



Leaf-spring landing gear, made of non-critical steel plate, used on primary trainers, is said to have been suggested by veteran racing pilot Steve Wittman



Developed by Firestone, this caterpillar landing gear gives four to eight times as much landing surface as a regulation tire for soft or sandy ground

LANDING GEAR

Why We Can't Lose

Victory FOR THE UNITED NATIONS IS IN THE CARDS. THE TRUMPS WE HOLD ARE MARKED "MILITARY CAPITAL", "FLEXIBILITY", AND "COMMUNICATIONS"

By FLETCHER PRATT *

WE CAN'T lose. For three main reasons we can't lose: three reasons which can be summed up under the headings of Flexibility, Military Capital, and Communications. Of these, only the third has really begun to produce its effects—but those effects have already given us victories on the enemy's doorstep in Sicily and the Solomons, and have made possible the battering from the air received by the German and Italian cities.

There is no possibility of the Axis transporting an army across the ocean to invade us. Our cities have not been bombed, and those of England and Russia are no longer attacked effectively.

That's what having good communications does for us—although, according to the classical doctrines of military science, the Axis communications are better than our own. They have what are called "interior lines"; they occupy great, irregular circles of territory, while our forces are spread around the outsides of both circles.

If we are attacking, the enemy can shift forces across the spokes of the wheel more rapidly than we can around the circumference. If he is attacking, he can concentrate tremendous force on any spot and break the circle before our forces can move around the long route. The Nazis demonstrated this in the Polish campaign by destroying that nation while France and England sat

* One of America's leading military and naval experts. Author or co-author of 15 books, including "Sea Power and Today's War," "America and Total War," and "The Navy Has Wings."

WHAT ARE COMMUNICATIONS?

In logistics, the military mathematics of movement and supply, communications are the routes and methods of transportation by which men and materials are taken to the points where they will serve the ends of strategy.

helpless. The Japanese demonstrated it in the capture of the Dutch East Indies.

Or so it seemed, for it is now clear that this view was hopelessly old-fashioned and the early success of the Axis was due to the fact they were ready for war while we were not. The idea that they had interior lines ignored two of the great modern inventions, the airplane and the submarine. British and American bombers could reach out across the whole German communications system, and have already done it so effectively that the construction of locomotives and motor trucks (which are communications equipment) have No. 1 priority in Germany, even ahead of weapons of war. The Japanese communications are by water; American submarines have already canceled an entire year's Japanese shipbuilding program, to say nothing of losses inflicted by our surface and aerial forces.

That is, the Axis main lines of communication are subject to attack while ours are not. The fact comes beautifully clear in the African and Sicilian campaigns. The forces we put in there were insignificant in comparison with the number of Axis troops available, but those reserve Axis troops stayed at the center of the circle while the men out on the rim took their licking. The Axis could neither support nor supply the places where fighting was going on.

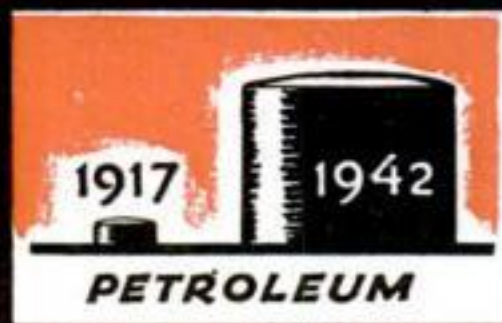
The Germans, to be sure, had ideas about this before the war started. They counted on disrupting our communications by the

ARTERIES OF VICTORY:

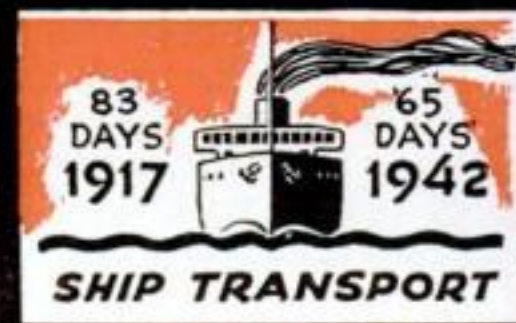
These lines of communication, stretching around the outside of the Axis defense arcs in the Pacific and in Europe, carry the troops, equipment, and supplies that are the life-blood of successful war. Although both Japan and Germany possess the theoretical advantage of operating on interior lines, their communications are much more subject to attack than ours. Our bombers blast German supply lines across continental Europe, and our submarines whittle down the convoys that feed Japan's far-flung armies



Allied bombers are smashing away at the vital rail lines of Axis Europe



We are shipping 80 times as much oil and oil products as in the last war



Ship turnaround, U. S. to Europe, has been cut 21 percent under 1917

use of submarines, and their U-boat campaign has so far been our deadliest danger. But it contained a fatal flaw: there was no battle fleet to back it up. The Allies in the Atlantic have been able to concentrate on the production of small anti-submarine craft and to put convoys under protection of the planes from little escort carriers. The Japs can't do this. If they try it, our big surface warships will kick in the teeth of their escorts as they did during the campaign for Guadalcanal. Moreover, if they put their

production into escort craft, they will fall hopelessly behind in the race to build battle-ships and big carriers. Then there will inevitably come a day when their surface ships will be driven from the sea and their whole communications system will collapse.

It may collapse anyway, for the Axis communications systems have the peculiarity that they do not run to the right places, and cannot unless the Axis somehow gains sea power to reach outside its circles. Both Germany and Japan are short of many of



Articles of great strategic importance are now carried by air. Glider trains, successfully tried on the Atlantic run, may supplement the big freight planes

Our trains move more than four times as many soldiers as in World War I

the essentials for war. This was foreseen in both countries. Before the conflict, which they hopefully imagined would be short, they laid in stockpiles. With every day, these come nearer exhaustion.

That is, in order to keep the war going they are spending out of capital, while the United Nations are working on current income. But the Axis exhaustion of its military capital does not stop merely with such matters as steel, in which Japan already has a shortage, and oil, in which a German short-

age will develop as the synthetic plants are hit from the air. It also concerns everything that goes to make up a war effort.

At the beginning of the conflict, the Axis was far below the nations now united against it in military potential. Germany and Japan enjoyed an advantage only in having their potential fully developed for conflict. "We must win a short war or lose a long one," said one of the greatest German strategists. The men around Hitler worked out a method by which they could gain what they wanted in a series of short wars.

It consisted in throwing the whole

strength of Germany onto the least formidable opponent, winning so quickly that the opponent's resources could be taken over undamaged and used in the next conquest. For a time it worked magnificently. The positions gained in Czechoslovakia and the big guns from the Skoda works made the conquest of Poland possible; the Polish antitank rifles and tanks from Czechoslovakia had much to do with the fall of France; aluminum from the French factories and gasoline from French stockpiles carried the Nazis through the Balkans and into the Ukraine.

What are the Germans fighting with today? In Africa our troops encountered tanks built for the French Army and artillery captured in Russia. What are the Germans eating today? Food plundered from Poland, Greece, France, and the Ukraine, while the people of those countries are on a starvation diet.

By their book, the system is perfect, and it *would* be perfect if they could keep it up. But it is a military version of the late Charles Ponzi's system of finance, which paid earlier investors out of money received from those who came later. Like Ponzi's system, it began to cave in as soon as there were no more investors. When the Spitfires halted the Nazis in the Battle of Britain, they were forced to go hunting more plunder in Russia; when the Russians stopped them at Stalingrad, they began everywhere to be beaten. Similarly, the Japs were everywhere and instantly on the defensive when their latest attempt to expand failed at Coral Sea and Midway.

In the case of the Germans, at least, failure to continue the advance entails far more serious consequences than the mere slow exhaustion produced by their material losses. The method of living off the subject populations can be continued for a long time, but these populations not only furnish the goods for the continued happy existence of Nazis; they also furnish the labor that produces the goods. If they don't eat, if they are killed off, they can't work.

As for replacing the lost slaves in the territories with more Germans, the answer is, what Germans? Before the war, Germany already had a declining birth rate in spite of Hitler's best efforts. The conquest of Czechoslovakia, Poland, and the Baltic states greatly increased the total number of Germans by bringing in the German-speaking elements in these countries, but it did nothing to change this tendency toward declining population. The terrific fighting in Russia has now added to it another element of decline in battlefield deaths and disablements. Germany is the only country in the war today where the casualties, so far as they can be discovered, outnumber the

births. We think we are hard up for manpower because the draft is getting down toward fathers. Over there, they are drilling 16-year-olds and have whole divisions of men over 45. Industry is allowed to keep only the physically totally unfit and a few essential managers and highly skilled workers. In manpower, also, the Germans are spending their capital. The only thing that can save them is a series of new victories, with new conquests, new sources of labor.

Though the Axis may win battles yet, and even minor campaigns, it seems altogether unlikely that there are any more great victories or conquests in the cards for them. They labor under the fatal disadvantage of not being democracies; which is to say that they have no means of correcting mistakes. They have no flexibility in command.

In the United States or Britain, when a leader falls down he is the target of a public opinion which can speak its mind and see to it that there is a change of methods. We have an instructive illustration in England, where the defeat in Norway brought about the fall of the Chamberlain government and its replacement by the administration of Churchill, with military changes.

Among the Axis powers this couldn't happen. The Nazis had a dreadful defeat in the Battle of Britain and another before Moscow in the fall of 1941. In the former, Hermann Goering of the Luftwaffe was the man who made the mistakes; but he was too big a shot to be removed, so nothing was changed in policy or strategy and the Luftwaffe went right on being beaten. After the Moscow failure, a lot of generals were changed; but the new leaders had to submit their plans for another campaign to the same old boss, Adolf the Great. Naturally, they had to accept his ideas and offer plans to carry them out; and those ideas as naturally took them straight to Stalingrad and El Alamein. It is the same in Japan. Any admiral in a democracy who lost such a battle as Coral Sea would also have lost his job, for public opinion would have set up against him a pressure as irresistible as it did against the men caught napping at Pearl Harbor. But Japan is a military dictatorship; Yamamoto stayed on the job and used the same methods to get himself the still more dreadful defeat of Midway.

It is sometimes said that we can be defeated only if we defeat ourselves, if we fail to apply our energies to make the most of what we have. It isn't true. The people of the democracies *want* to win this war, and if their leaders fail to rouse them, fail to impose upon them the necessary sacrifices, it will become apparent from the progress of the war—and they will replace those leaders.

We can't lose.



Its top five feet below present water level, the new stone weir extends from 400 to 1,400 feet out from Canada's shore. Left, cross section of the 40-foot-wide weir

Weir Boosts Niagara Power

TO INCREASE the hydroelectric-power output of Niagara Falls—and, incidentally, to preserve their natural beauty—a stone weir has been built across the Canadian half of the Niagara River bed. War industries on both sides of the border profit from an international agreement, of which this project is part, to increase the amount of water used for power from 56,000 to 82,500 cubic feet per second. Diverting natural flow, the weir has raised the level of water going over

the American Fall one foot. Stretching of a cable to carry stones out over the swift current involved building a 2,200-foot causeway into the river from Goat Island, on which to set up one of the two towers. From this cable, stones as heavy as ten tons were dropped. Diversion of water by the weir makes the American Fall more beautiful than it has been in a generation, and retards erosion which has been rapidly changing the famous Canadian Horseshoe into an acute angle.



To the White House go the ten heroes of the production front to receive the hearty congratulations of the President and to be awarded Citations or Certificates of Individual Production Merit for their invaluable contributions to the war effort. Later WPB Chief Donald M. Nelson gave a luncheon in their honor



Nightmares To Order - for Hitler

By RAY MILLHOLLAND

IT REQUIRES no great imagination to reconstruct the scene at Hitler's headquarters on the night that the British Eighth Army blew the lid off at El Alamein. Rommel had just sent a wire to his boss, saying he had that mouthy little squirt, Montgomery, backed up against Alexandria and was about to blast him with those invincible German 88-millimeter tank guns and then sweep all North Africa bare of British resistance with a thousand tanks flying the black swastika. Heil Hitler!

So the little house painter who had painted whole cities red with human blood crawled into bed to dream of his coming triumph on the morrow. Before dozing off, he had a few little details to decide. . . . No, he wouldn't head the triumphal parade through the streets of Alexandria. That might interfere with a previous date to stand in Red Square in Moscow and watch the Kremlin go up in flames. Let the little fathead Mussolini play stooge for him at Alexandria. Now for a good night's sleep.

But shortly after dawn the arch murderer

of all time was awakened by an apologetic aide bearing a dispatch from Rommel.

It read: "Two-thirds of my tanks destroyed by new secret weapon of the enemy. Making strategic withdrawal to Halfaya Pass, where I propose to ambush and destroy the British Eighth Army. Heil Hitler!"

That morning Hitler's breakfast consisted solely of the fringe of his bedroom rug, which he tore off in great mouthfuls in frustrated rage. They can't do this to me—me, The Fuehrer!

Just the same, the British Eighth Army *had* done it. But not entirely on its own. Six thousand or more miles away, in the buzzing war factories of the United States, ten Yankee mechanics and engineers had each furnished an idea which put an end for all time to Hitler's nights of dreamless sleep.

Which one of these ten Yanks deserves the title of chief sleep buster to Hitler is neither here nor there. It was the combination of their ideas, skillfully employed by their tough fighting comrades of the British Eighth Army, that robbed Hitler of a victory already counted in the bag and eventually made second-hand merchandise out of



THE STORY OF TEN PRODUCTION HEROES WHOSE "BRAIN CHILDREN" HAVE BECOME HEADACHES FOR THE AXIS

every gun and plane and tank with which Rommel had started out to tour Africa.

Perhaps the most spectacular of these Yank ideas was the one contributed by Clinton R. Hanna, of the vast Westinghouse arsenal at East Pittsburgh. A hair-raisingly short time—as the Army measures such events—before the Battle of El Alamein, research worker Hanna left the East Pittsburgh plant for one of the ordnance proving grounds with a new device almost as complicated as the now famous Norden bomb-sight.

The device was transferred to a waiting tank. Hanna pulled on a suit of coveralls, fitted on a tank's helmet, and crawled aboard.

The big tank lurched into motion, rumbling toward the crest of a low ridge. Beyond that ridge, about two miles away, was the target, a board shack about the size and shape of a German tank, built low to the ground and no easy mark to hit. Up the back slope raced the tank, with Hanna strapped in the gunner's seat, the ponderous war machine roaring and grinding and lurching erratically. Then over the top!

Suddenly, Hanna's finger closed on the trigger. The tank's heavy gun dived back on the recoil slide. The tank commander stopped his machine and peered down below at Hanna.

"What's the matter, mister? Your finger slip?"

"No, Captain. We were on the target. So I let go."

Just then a walkie-talkie observer, stationed in a bombproof shelter close to the target, piped up: "Direct hit. Target destroyed. Proceed to next firing problem."

How can the new Hanna-equipped American tank make direct hits on enemy tanks two miles away while on the gallop? The answer lies in a robot known as a gyro-stabilizer, which keeps the gun barrel at a fixed elevation and the target in focus of the gunner's telescopic sight despite the pitch of the tank. The gunner can fire quickly and effectively, making only slight manual adjustments when necessary.

Without knowing at the time what a wow of an idea bit him, Dan Mallett, a machinist in the Borg-Warner Mechanics Universal Joint plant at Rockford, Ill., pitched another



FIELD TELEPHONES

Madison E. Butler's contribution to the war effort is an automatic lamp indicator which, in the testing of Army field telephone switchboards, has resulted in the saving of some 11,000 man-days of precious production time

Photos by Office of War Information



CASTINGS

A new type of calipering gauge developed by Stanley Crawford, raw-material inspector at RCA's Camden, N. J., plant, is now saving from the junk pile 13 out of 16 hollow castings formerly rejected because of faulty "coring"



TANK GUNNERY

Clinton R. Hanna, Westinghouse research worker, developed a stabilizer that makes it possible for a tank to hit a target two miles away while roaring full speed over rough ground. His device helped rout Rommel



COLD WELDING

Walter Hill's invaluable process of cold-welding metal hasn't begun to be exploited. To date it has merely saved millions of pounds of copper, besides markedly increasing the range and accuracy of one of our automatic weapons



WELDING

The day after Pearl Harbor, music-teacher Herbert James patriotically became a steel-mill worker—and then he went all out by discovering a new and better way of welding tungsten carbide tips to big shell-turning tools

Yankee strike over the pan in that same battle. After the British Eighth Army had retreated for the last time, back from Tobruk to El Alamein, it was short of tanks, short of guns, and desperately short of shells. Every resource of the United States was strained to the utmost to re-equip the British Eighth Army before it was too late.

Dan Mallett's contribution was an idea for a new counterbore tool that opened wide a bottleneck in fuse-body production. Dan's idea was simple—just combining several different tools into one. But nobody, including the company's high-salaried production engineers, had thought of it before. Yes, Dan Mallett, hard-fisted Yank mechanic, pitched one down the groove that helped blast Rommel out of El Alamein and kept him back-pedaling for 1,600 miles. More shells, with Dan Mallett's personal sentiments attached, drove the German tanks back at Kasserine Pass; they kept on coming in increasing quantities until the Yank Second Army had to race like hell to beat the British Tommies—also pitching fuse bodies a la Mallett—into Bizerte.

Bad news is supposed to come in threes. Yes, and then some, maybe. Joe Kautsky, a 63-year-old toolmaker for the Link Belt Company, of Indianapolis, Ind., is entitled to claim a little credit for giving Hitler at least one bad night.

Joe's company was making small hardened and ground precision parts for any of the big prime contractors who wanted them made "close" and made right. The only trouble was that contractors for both tanks and airplane engines, for instance, wanted at the same time all the production available from the same size grinding machines in Joe's plant. That meant that some days a number of the larger grinding machines would stand idle while the smaller machines were smoking hot from overloading.

Joe devised an entirely new type of spindle-nose attachment that would fit all sizes of machines, so that they could all be thrown into production of any size part. Joe's spindle-nose attachment is now being used all through the war-production program. Heil Hitler!

Coming in on a wing and a prayer—! The Yank Flying Forts are able to do that, even with bullet holes

through every gas tank, because James A. Merrill, research chemist for the Goodyear Tire and Rubber Company, found another use for ladies' stockings. That is all censorship will permit. One of Hitler's worst nightmares.

And just as though it weren't a dirty enough trick to play on Hitler, keeping the Flying Forts flying after they were shot full of holes, along comes another Yank with an idea hotter than a depot stove for keeping their bombs dropping smack on their targets. Edwin C. Tracy, field service man for the RCA Manufacturing Company, Camden, N. J., plant, has developed a field-checking set that can be lugged right into a bomber just before taking off, so that its flight instruments can be calibrated to frog-hair accuracy. Now, in three minutes' time, instead of the many days required to dismantle a plane's flight instruments and put them through elaborate laboratory tests, Ed Tracy's checking instrument can send a bomber roaring off the runway with every bomb guaranteed to land where the bombardier points his Norden bombsight. The only one left guessing is Hitler.

Walter P. Hill, a former turret-lathe operator and automobile-repair mechanic, and now a development engineer for the Wolverine Tube Division of Calumet and Hecla Consolidated Copper Company, of Detroit, has staged a one-man blitz all his own and there would be dancing along Unter den Linden tonight if Walter would only develop a permanent case of amnesia and forget all he knows about how to make cold metal weld itself to cold metal.

Reduced to its simplest elements, Hill hit upon the idea of taking a brass tube and, with a small tool that costs about two dollars or less to make, closing the end of the tube without the use of any externally applied heat, such as from a welder's torch or a brazing flame. He starts with a cold piece of metal and finishes with one end of the tube closed in a perfect metallurgical weld. After he had worked the bugs out of his process on brass tubing, he discovered the same process worked on steel tubing!

There is no limit in sight, yet, for applications of the Hill process for cold-welding metal. At least a half dozen appli- *(Continued on page 202)*

PRECISION GRINDING

Joe Kautsky, 63-year-old tool maker, figured out a new kind of spindle-nose attachment that fits all sizes of precision grinders, and thus enables them to be kept in round-the-clock service, working on parts of different sizes



SHELL FUSES

By combining a number of tools into one, machinist Dan Mallett came up with a new kind of counterbore tool that cracked open a bottleneck in fuse-body production. These fuses detonated the shells the Yanks dropped on Bizerte



FUEL TANKS

Because James A. Merrill, a Goodyear chemist, has found a new and highly secret use for women's stockings, Allied planes will still be able to wing their way home long after their gasoline tanks have been plugged full of holes



AIRPLANE ENGINES

Out at the Packard Motor Car Company, rookie machinist George Smolarek startled the engineering experts by "telescoping" three operations into one and thus greatly speeded up production on British Rolls-Royce engine parts



FLIGHT INSTRUMENTS

A timesaving field-checking set that tests a bomber's flight instruments just before the take-off has been developed by Ed Tracy. In three minutes a bomber can be sent off, guaranteed to unload its eggs where they are aimed



Hit Where It Hurts!

TIPS ON BARE-HANDED DEFENSE AGAINST THUGS



THE SABER SLASH, a chopping jab, is delivered with the edge of your hand. Be sure the wrist is rigid and fingers all stiff



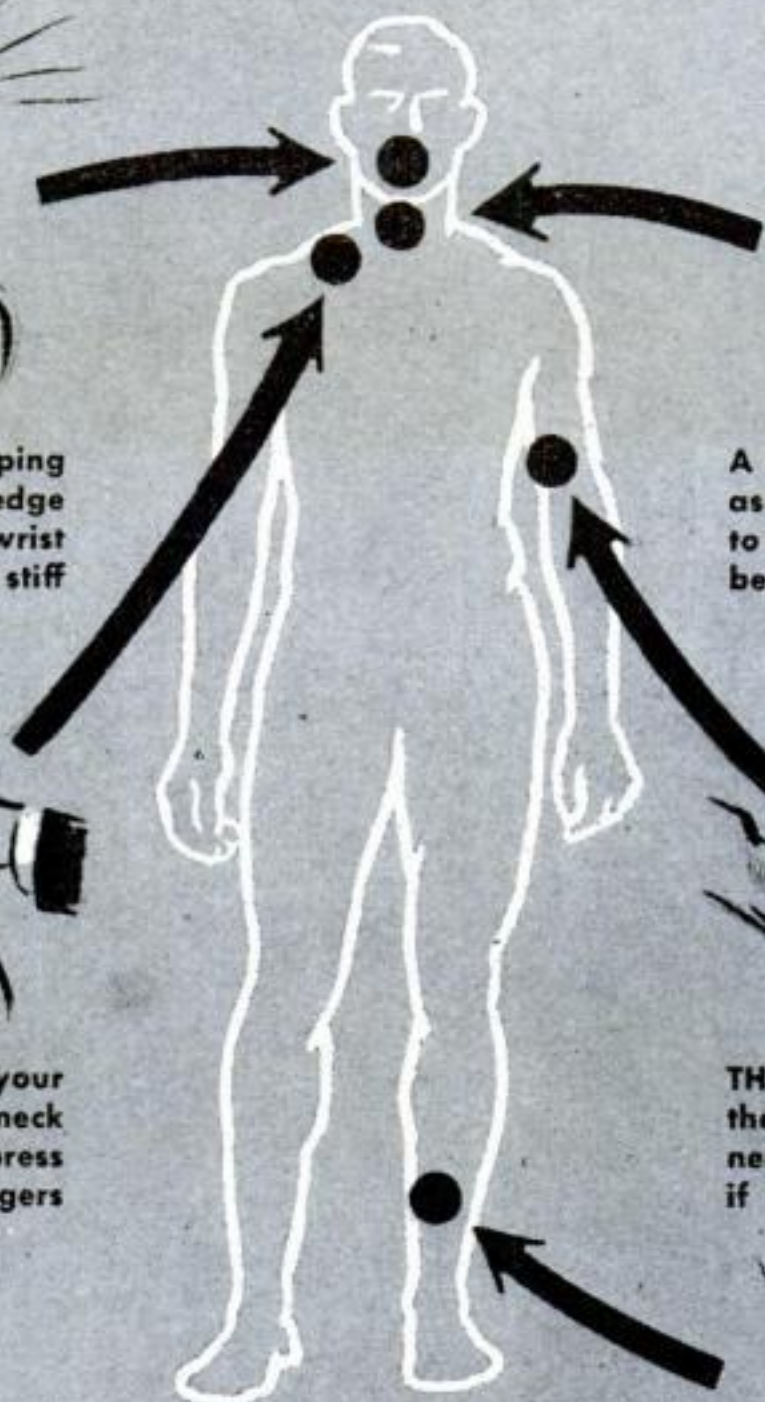
A CHIN JAB is as effective as a right to the jaw and easy to put across. The hand must be cupped and wrist held stiff



THE PINCERS GRIP. Thrust your thumb into your opponent's neck or shoulder muscles, then press downwards against your fingers



THE KNUCKLE BORE, applied to the "funny bone" or some other nerve center, will do the trick if there's no room for slashing



A BACKWARD KICK on your opponent's shin or instep, or a stamp on his toes, is a good way to break a hold

AGGRESSIVE defense against bodily attack, and skillful offensive tactics against an unarmed opponent, are easy if you learn the basic principles taught American Ranger and Raider battalions. The whole secret lies in disabling the enemy by locating the main nerve centers in his body and bringing pressure against them to cause extreme pain or temporary paralysis.

Of the five natural weapons at any man's disposal, the most useful is what might be called the "saber slash." This deadly blow, administered with the edge of a stiffened hand, can often knock your opponent out when applied to the base of the nose, just below the biceps, just above the wrist, on the upper forearm, or against the windpipe. The kidneys and both sides of the trunk, at about the fifth or sixth ribs, are also vulnerable spots for a slashing attack.

The "knuckle bore" is a telling substitute for the saber slash in close-quarter fighting. The weapon in this case is the knuckle of the middle finger raised to form a wedge above the fist. The pincers grip—applied by thrusting a thumb into your enemy's muscle and pressing downwards against

the fingers—will also cause a sharp, disabling pain at the shoulder, against the jugular vein, between the collarbone and the base of the neck, or in the soft spots at the base of the ear.

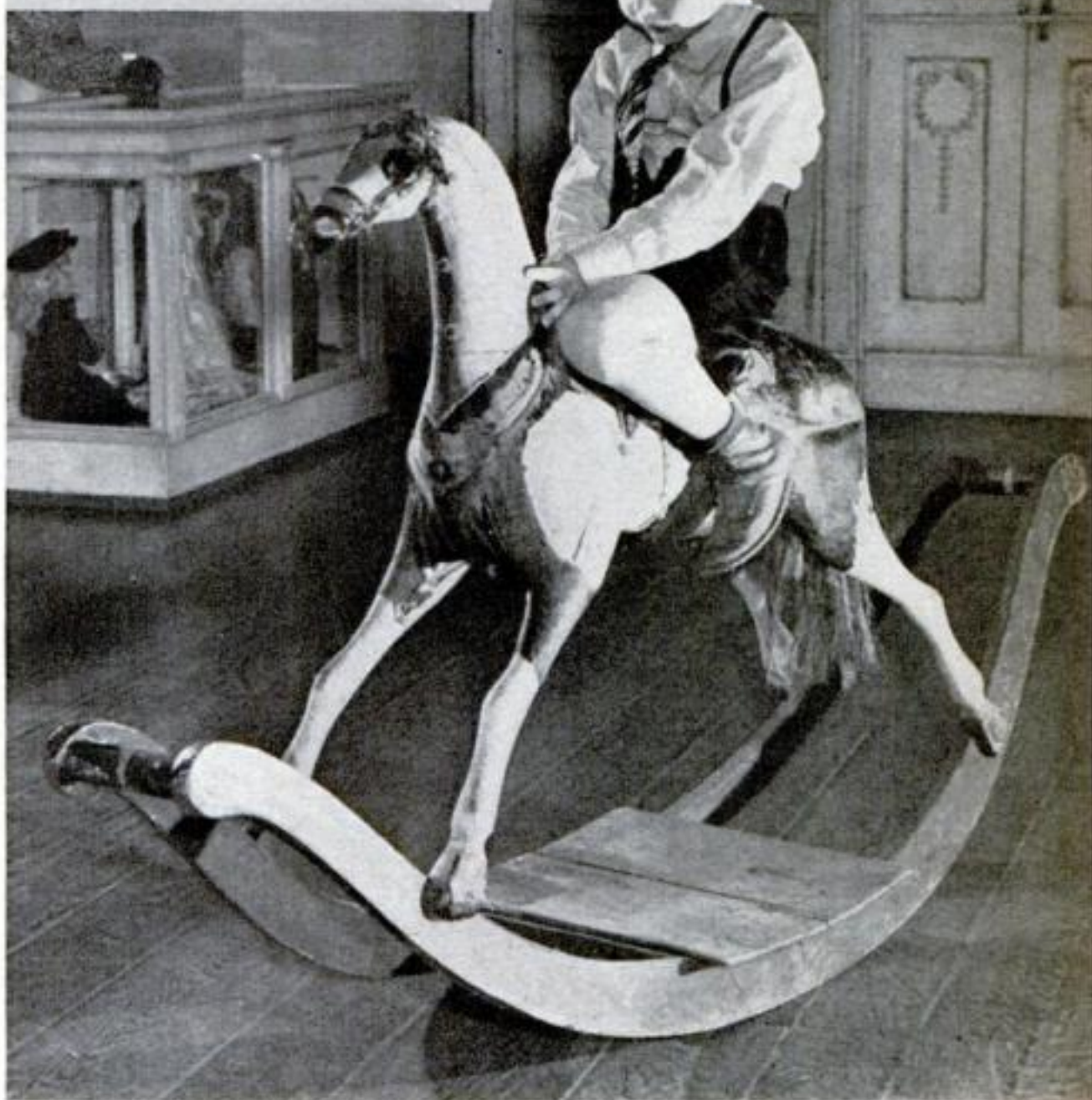
If you are attacked and caught from behind, one method of escaping is to work an arm free and direct a blow with your elbow at your attacker's solar plexus, at the point where the lowest ribs join the breastbone. Failing this, you can kick him smartly on shin or instep, or stamp on his toes, causing him such sharp pain that he will relax his hold.

Finally, there is the chin jab, as staggering as a right to the jaw and easier to deliver—a short, jolting, upward motion of the cupped hand with the full weight of the body behind it.

Playthings When Grandpa Was a Boy

GRANDFATHER'S toys were as representative of their time as ours are of today. The Old Toy Shop recently installed in the Museum of the City of New York exemplifies the new interest in mechanics, the desire for realism, and the urge for elegance characteristic of the 19th century. Not only did carriages and trains "go," but little mechanical men and animals performed all kinds of activities. Dolls had real hair and rocking horses real manes. Bicycle seats were upholstered, some even fringed; and doll houses displayed the Victorian passion for elaborate elegance.

Still ready for a gallop, this realistic Victorian rocking horse is one of the old playthings in the "toy shop" exhibit at the Museum of the City of New York



ROBOT CELLIST bows his cello realistically and plays a lively tune when wound. A ring on the bridge guides his bow

MIRRORSCOPE, early "movie" device. Whirl the outer ring of prints and their swift, consecutive reflection in the center mirror produces movies

UNCLE SAM BANK. Put the coin in his hand, press a button, and he will drop coin into a satchel

WOODEN TRICYCLE of the 80's, built not so much for speed as for elegance, has wood frame and wheels, and a seat upholstered in carpeting

"REAL" COOK STOVE, wood-burning, with a stovepipe to carry off the real smoke, and equipped with an oven and real copper kettles for cooking a real Victorian meal



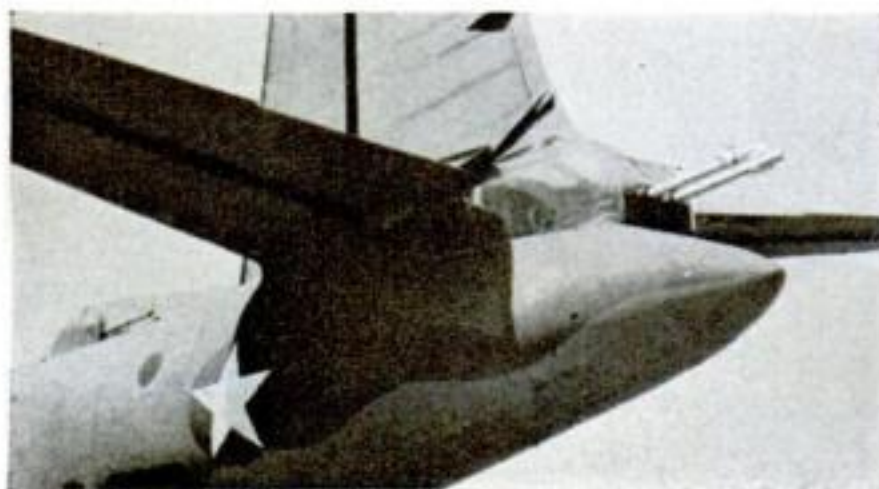


NIGHT FIGHTER. Latest version of the famous Douglas A-20 Havoc and Boston attack bomber is a night-fighting terror. The nose section, normally occupied by the bombardier's compartment, houses a battery of .50 caliber machine guns, while other guns protrude from the belly. The British early discovered the night-fighting potentialities of the A-20 and adapted it for intrusion work over Nazi airfields—pouncing on bombers returning from raids.



FIGHTER TURNS PHOTOGRAPHER. Lockheed's F-5 (below) is the familiar P-38 Lightning with guns and other equipment removed to make room for five high-speed cameras. Fully armed, the P-38 is the fastest and one of the hardest-hitting planes in the air. Stripped down as the F-5, it must rely on its phenomenal speed as its sole protection. Its mission is to duck into enemy territory, get its pictures, and then scoot for home. Unlike the P-38, the F-5 is a two-place plane, the photographer sitting "pickaback" behind the pilot.

NEW ARMAMENT gives the Martin B-26 Marauder deadlier fire power than ever. The latest model has twelve .50 caliber guns: one fixed and one flexible in the nose; two each in the upper turret and the tail (shown below); two each in the upper and lower fuselage; and two side guns.



Tricks with Figures

MAGIC SQUARES

IN INDIA, today, our soldiers may see little metal plates, bearing numbers arranged in squares, worn by the natives as amulets. These are "magic" squares, first constructed by ancient Hindu and Chinese mathematicians, and believed to be endowed with magical powers because of certain remarkable but purely mathematical properties which they possessed.

But no magic is needed to construct these squares. The simplest of them, that of the "odd order," is as easy to make as counting.

Draw a square. Mark it off each way into the same odd number of parts—here, for simplification, three in each direction.

In the middle square of the top row place the figure 1. (See below.) Normal progress is diagonally upward to the right; when this is impossible, certain substitute moves are prescribed. For instance, moving upward to the right of 1 takes you outside the square above the third vertical column; therefore, the 2 is carried to the bottom square in that column. Similarly, the next normal move carries you outside the square in the second horizontal line, and so here you take your 3 to the extreme left square in that line. When you find a square is already occupied, place the next number directly below the one preceding it. Your 4, then, is set directly below your 3; your 5 and 6, in a line upward to the right of 4. When, as in the next instance, the normal move carries you outside the square both vertically and horizontally, you place the next number, as you did in coming to an occupied square, directly below the preceding number. This puts 7 in the middle square of the right column. Your 8, falling to the right of the top line, is carried to the extreme left square; and your 9, similarly, falling above the second column,

The method of making any odd-order square explained in the text is illustrated below. And in the seventh-order square, right, notice that the inner concentric squares of smaller odd orders also possess certain "magic" qualities

must be carried to the bottom square. Your square is now complete.

Because it is divided into three parts in each direction, this is called a magic square of the third order. Squares of any odd number may be made in the same way.

In these squares the ancients noticed many remarkable properties. In any straight line—vertically, horizontally, or corner to corner, the numbers add up to the same total, the magic constant. The number in the middle square is always the middle number in the series. The sum of any number and its opposite with respect to the center square is the same throughout. You may add any number to every number in the square without changing the properties of the whole. If you look for them, you may find other magic qualities in the square.

This square may be varied without changing the interrelations of the numbers. Rotation on a plane in angles of 90 degrees forms three variations; reflection in a mirror from all sides provides four more equivalent squares.

There are other types of magic squares and different ways of making them. Making squares of any even order calls for another procedure from that detailed above, and demands separate treatment.

30	39	48	1	10	19	28
38	47	7	9	18	27	29
46	6	8	17	26	35	37
5	14	16	25	34	36	45
13	15	24	33	42	44	4
21	23	32	41	43	3	12
22	31	40	49	2	11	20

2							9
	1			1	6	8	8
			3	5	7	8	3
		2			2		4

Industry Uses 3,000 Types of Files



Nicholson File Company, Providence, R. I.

Hand Tool

By

JEAN ACKERMANN

WINGS, propellers, engines—practically every inch of our warplanes needs a filing job before it is ready for action. Tiny Swiss Pattern files are used to form dies and to clean out slots; a curved-tooth file roughs down a wing surface; a rasp trims the edge of a propeller—and 2,000 other files perform special jobs necessary to put a plane into the air.

But it isn't only in aircraft building that files are "musts." They are needed to smooth shells and gun barrels, to sharpen farm tools, to make emergency repairs in combat zones, and to do a wide variety of general maintenance work in the shipyard and factory. On an increasing number of counts, the "stepchild of the machine shop" is becoming a highly respected war weapon; to perform the many tasks that are being assigned to it, it is made in no less than 3,000 specialized types, varying in size and shape and in the qualities of coarseness,

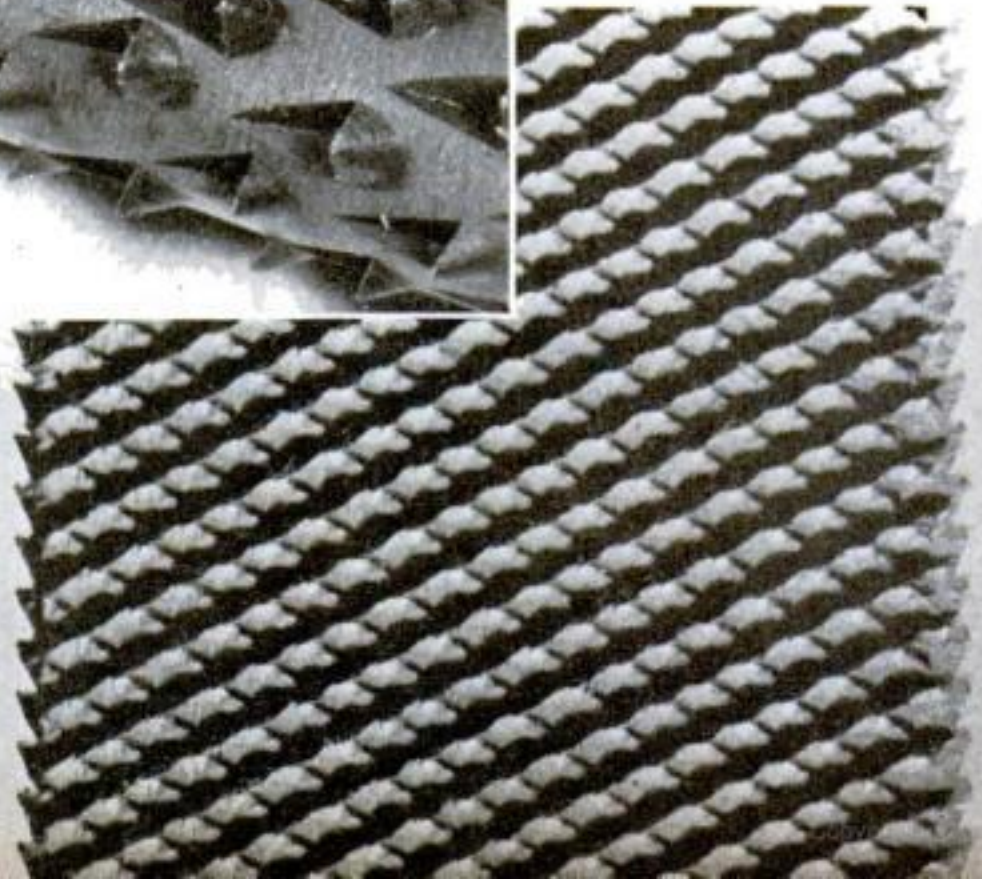
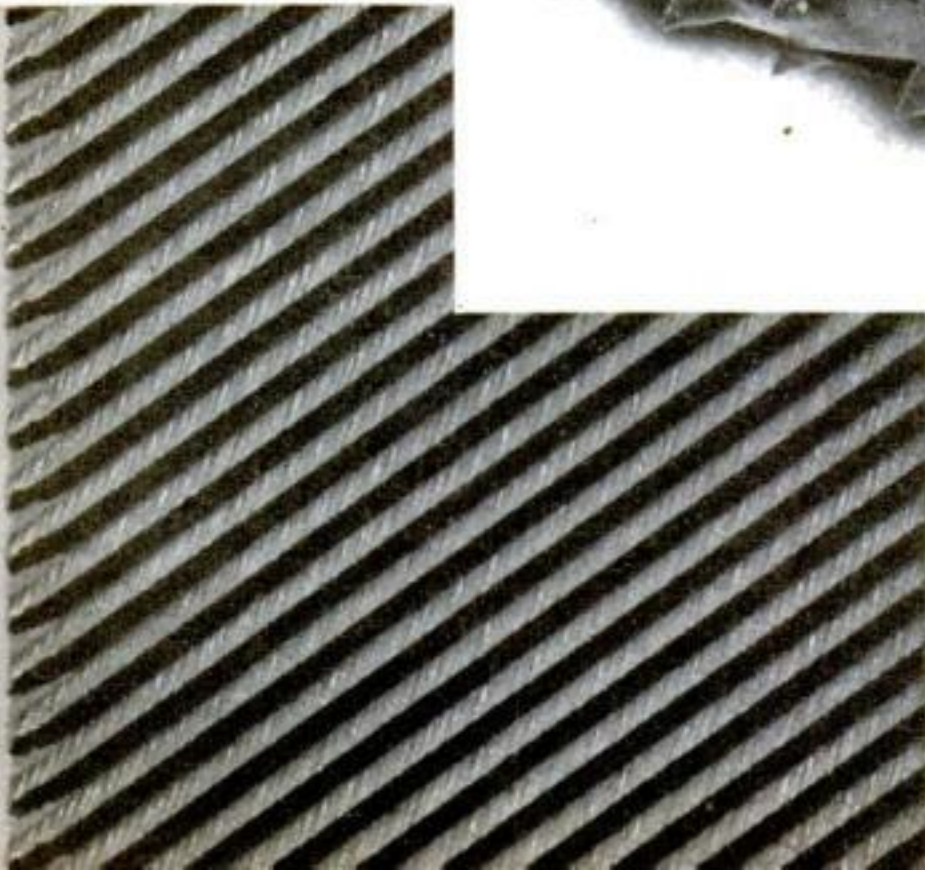
**Once the "Stepchild of the Machine Shop,"
the File Has Now Become a Much-Respected
"Weapon" of War on All Industrial Fronts**

SOME OF THE MANY TYPES OF FILES AND THE

These photomicrographs show the patterns of a regular single-cut file (below), a double-cut file (lower right), and a wood rasp (at right)



Essential differences between a single-cut and a double-cut file are: the first leaves a smoother surface; the second cuts faster



of Mechanized Warfare

angle, and pattern of their cutting teeth.


















Today's file, for instance, may be either needle size or two feet long; it may be square, round, triangular, or wedge-shaped; and it may have anywhere from four to 350 teeth to the inch. In general, however, files average from eight to 14 inches in length (except the precision-made Swiss Patterns, which average six inches), and have teeth that are standardized into one of four cuts and arranged in any of five patterns. In structure, all 3,000 types are basically alike, and all pass through the same six steps of manufacture—which have now been mechanized to lightning speed and hairbreadth precision by the ingenuity of such American file makers as Nicholson, Heller, Disston, Plumb, Atkins, and Simonds. While some details of manufacture are closely guarded secrets, the main steps are simple ones and standardized throughout the industry.

Following the well-known 10-inch flat file through the processes of its manufacture gives a good picture of file making in general.

To begin with, a file may very often have to work on hard metals, so only the best high-carbon steels are considered suitable "file steel." Steel mills deliver the metal to the file maker in specially shaped bars, which are promptly sheared into rough blanks a half inch longer than the finished file will be. A file's rated length includes

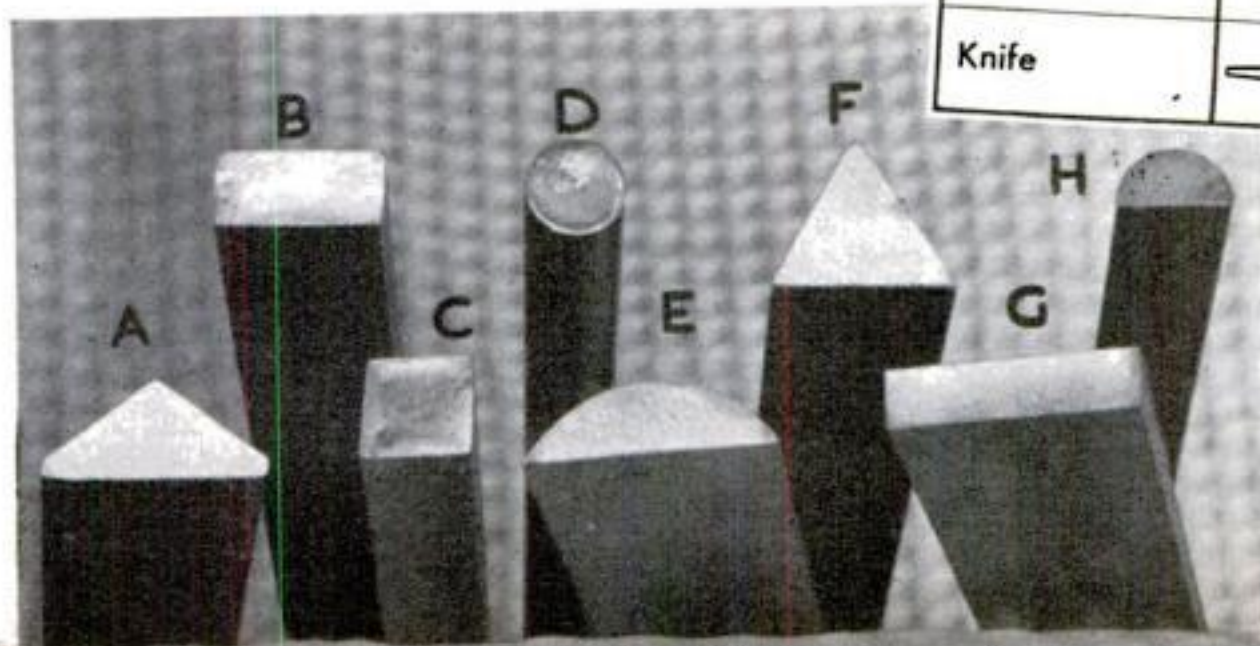
only the cutting blade, exclusive of the metal handle, or "tang," which is formed under a trip hammer into a two-inch projection tapering sharply to a blunt point.

Since the blank is too hard and brittle to have teeth cut into it, it is placed in an an-

SHAPE	CROSS SECTION	GENERAL USES
Mill		Sharpening mill, ice and circular saws, axes, implements, knives, shears, tools; lathe work; draw filing; polishing
Taper or Three Cornered		Sharpening saws, axes and milling cutters
Slim Taper		Sharpening circular, cross-cut and buck saws
Extra Slim Taper		Sharpening fine-tooth hand and hack saws
Double Extra Slim Taper		Sharpening fine-tooth saws
Cant Saw		Filing M-shaped teeth of cross-cut saws
Cross-Cut		Sharpening cross-cut saws of the great American type. Also wood or buck saws
Pit Saw		Filing teeth of pit or frame saws
Flat		A general-purpose file. Good for flat surfaces
Hand		Another general-purpose file for angles, corners, flat surfaces
Pillar		Keyways, slots and narrow work
Warding		Narrow work requiring thin file. Making keys
Square		Corners, grooves, keyways, slots
Three Square		Acute angles, corners, grooves, notches
Round		Holes, shaping curved surfaces
Half Round		Concave corners, crevices, rounding holes
Knife		Cleaning out acute angles, corners, slots

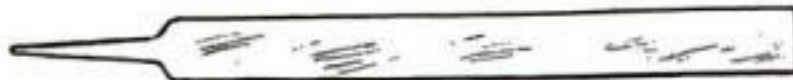
JOBS THEY PERFORM

At right is a descriptive list of only a very few of the many hundreds of files which, varying in size and shape, and in the coarseness, angle, and pattern of their cutting teeth, are speeding up war production in the factories, shipyards, and farms of the nation. The first eight files shown at the right are single cuts; the rest are double cuts. The diagramed sketch below shows the principal parts of a file



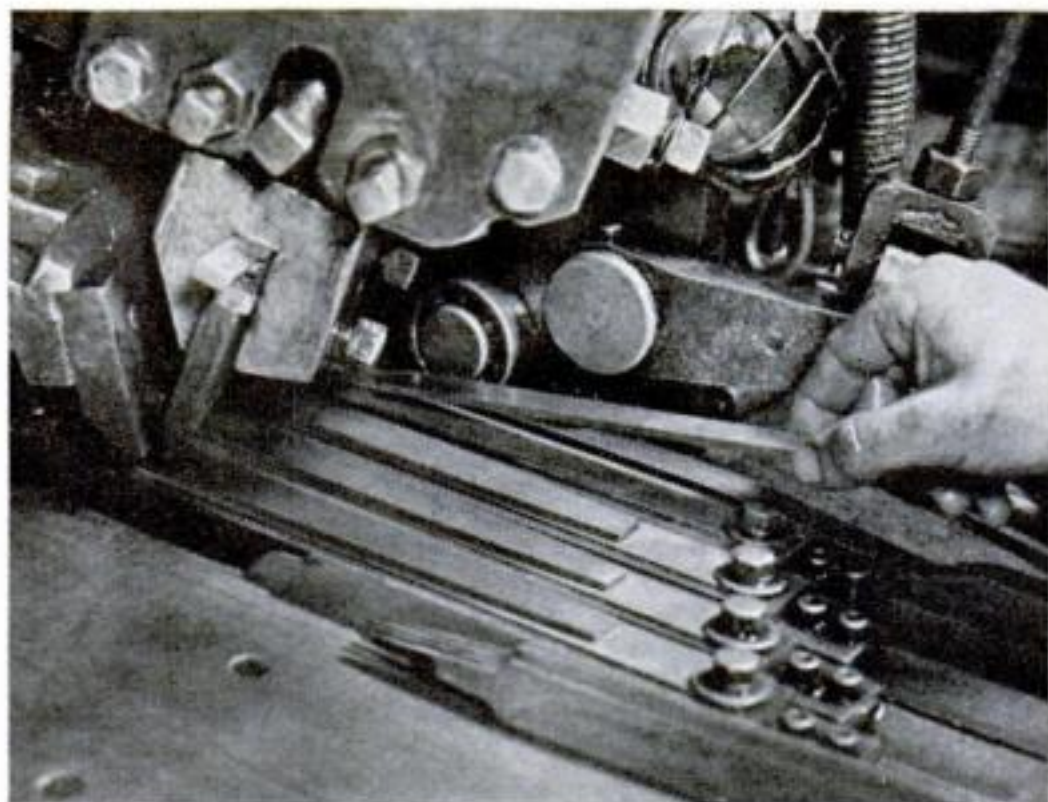
The most common types of files—without which most machine shops could not operate efficiently—are the cant, flat, square, round, half-round, taper saw, warding, and pit, reading from A to H at left

How Files Are Made



BLANK File making begins with the shearing of high-carbon steel bars into the approximate lengths and widths of the finished files. The operator above is shown inserting a pair of bars into the cutting machine. Bars are delivered to the file maker specially shaped for cutting

TANG A file has two main parts: its blade, or cutting surface, and a bluntly pointed end, which is called the tang. Shaping the tang is done with a drop hammer, which delivers about nine strokes to the top and sides of the end of the blank. Unlike the piece above, blanks are usually tanged before their teeth are cut



SMOOTHING To give them their final finishing before teeth are cut into them, the blanks are "stripped," or drawfiled, by pulling a file sideways across them at a fixed pressure

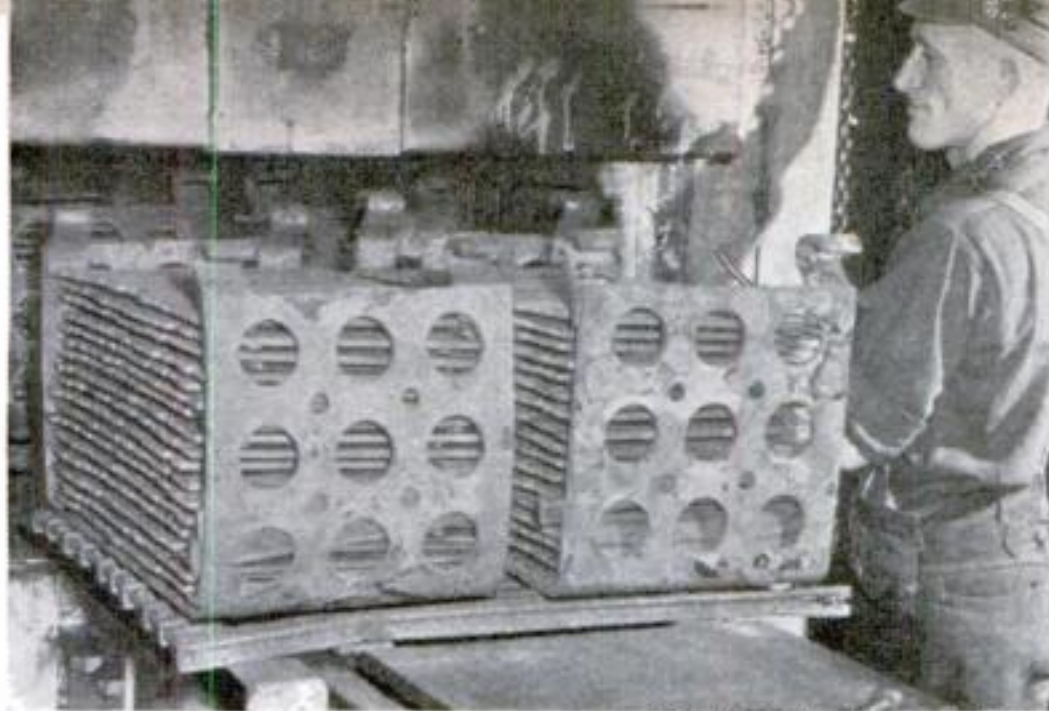
CUTTING A power-driven chisel set at an angle to the longitudinal axes of the blanks comes down on four of them at the same time. With each stroke of the chisel, blanks are inched forward for next cut

nealing oven, heated to about 1,425 degrees F., and then left to cool. It is then mechanically straightened out to remove "heat warp" and ground to a smooth surface. Remaining microscopic irregularities are "stripped" away by pulling a sharp file sideways across the blank.

In the cutting machine, the blank, along with three other similar blanks, is fastened on a zinc-covered lead foundation. Above is a power-driven chisel which comes down repeatedly on all four blanks to form razor-edged ridges. With each cut of the chisel,

the foundation inches forward to await the next cut. This first cutting takes but a few seconds. If the file is to be single-cut, it is now ready for hardening. If double-cut, it is shifted around so that the chisel can cut another set of ridges at a different angle.

Other, less common, files must be made in different types of machines. The coarse teeth of the rasp are individually formed with a heavy punching tool; the ridges on a curved-tooth file are milled on a circular cutter; and the tiny teeth of the Swiss Pattern group must be cut with the most exacting



Photographs taken at Heller Brothers Company, Newcomerstown, Ohio, by William W. Mor



ANNEALING Because the high-carbon steel blank is much too hard to permit the cutting of the file's teeth, it must be heated in an oven to 1,425 degrees F. and then allowed to cool slowly. This annealing, which takes nearly an hour, gradually reduces the blank's resistance to about a 90-B Rockwell hardness

GRINDING After blanks have been straightened to remove the "heat warp," they are placed on a circular revolving platform where, one by one, they are brought under a grinding wheel for rough finishing, preparatory to having their teeth cut. Water cools the blanks as they leave grinders



CLEANING This is done by holding the file under a sandblasting hose which spews out silicon at a pressure of 180 pounds

REHARDENING After a few minutes in a molten-lead bath, the files are soaked in brine

TESTING Steel of 53-C Rockwell hardness is drawn across files to determine depth of their bite. Files are then "rung" by being hit on steel block

care and accuracy on precision machines.

On a single-cut file, the ridges lie across the file at an angle to the longitudinal axis of between 65 and 85 degrees. If the file is double-cut the first set of ridges is cut at only a 40-degree angle, with the second set crisscrossing the first at a 70 to 80-degree angle to the longitudinal axis. Generally both edges of a file are given a single set of ridges, although in some instances one edge, or even one face, may be left blank to prevent damage to adjacent metal when the file is being used on a small job.

The coarseness of a file is determined by how close together its teeth are. Cuts of American Pattern files range from the pinpoint surface of "double dead smooth" through "smooth," "second cut," "bastard," "coarse," to "die," which has teeth about a sixteenth of an inch high. The fine cuts of Swiss Pattern files range from No. 00 to No. 6 (very smooth), while curved-tooth files run from "standard" through "fine" and "smooth" to "dead smooth." It must be remembered, however, that the grain of a file varies with its length, so that the various de-

grees of coarseness are purely relative.

After its teeth are cut, the file is re-hardened by being coated with a paste that shields the teeth from oxidation, and then being dipped up to its tang in a lead bath maintained at 1,425 degrees F. After a few minutes it is withdrawn and plunged into a brine bath at 80 degrees F. Emerging from this, the file is as hard as any metal it may encounter.

Washed with high-pressure sandblasting, and oiled, the file is ready to be tested. The standard "workout" is several strokes on a block of high-carbon steel (53-C Rockwell hardness) to determine the depth of its bite and the length of the shavings. If it passes that test, it is then "rung" (struck sharply) on a second block, to determine whether it has incurred any water cracks in the brine bath. If found to be flawless, its tang is oven-tempered for greater strength, and the entire file is then given a rust-preventing coat of oil preparatory to shipping.

Choosing the right file for a job can usually be done merely by observing the length of the file, for it is the length that governs the width and depth of the tool as well as its coarseness. Other things being equal, a long file should be chosen for rough work; a short one for delicate work.

But what most sharply distinguishes files from each other, and from rasps, is the character of the tooth cut. Each of the five patterns—single-cut, double-cut, rasp, curved-tooth, and Swiss Pattern—has its own sphere of work where another file is unable to compete. Take the simple single-cut file. Its one set of ridges do clean work and leave a smooth, even surface. But it does its work slowly. Consequently, single-cut files are, for the most part, restricted to finishing stock where a smooth surface is desired, removing thin layers of stock from large areas, and sharpening cutting tools. Variations of the single-cut tool are used for the first two tasks; for sharpening, there is a group of specially shaped saw files, such as band saw, pit saw, and crosscut files, each designed to fit snugly into the gullets of the teeth of some saw. Another single-cut type is the lead float, whose coarse, widely spaced ridges make it particularly suitable for soft metals such as lead, babbitt, and brass, which would clog finer-toothed tools. For lathe filing, there is a special long-angle, single-cut file that quickly clears itself of metal shavings while in action.

With their hundreds of tiny teeth, double-cut files work faster, though less smoothly, than single-cuts. Available in every conceivable geometric shape, they can meet almost any filing need, and are a universal fixture in the machine shop.

The rasp is to wood what the file is to

metal. Its coarse, widely spaced teeth can take a good bite out of soft surfaces such as wood, plastic, aluminum, and leather without becoming clogged. Varying in its coarseness, the rasp is an indispensable tool of the blacksmith, woodworker, plumber, and shoemaker. Even the aircraft industry is using a new rasp specially designed for quick filing on aluminum propellers.

Curved-toothed files, newcomers in the field, were originally designed and successfully used for smoothing the rounded surfaces of auto bodies. Now they are doing the same job on airplanes. These flexible files, worked in a special holder, will conform to concave, convex, or level surfaces. One version, with a standard cut on one face and a fine cut on the other, is a regular tool for boat mechanics and ground forces at air fields.

Swiss Pattern files are actually only miniature double-cut files, but being made with precision machines, and possessing a much greater accuracy than the American Pattern types, they are grouped separately. They are used for shaping industrial dies and tools, and are a necessity to the watchmaker, jewelry maker, locksmith, dentist, and other technicians dealing in delicate metal work. Some of the unusual shapes in which these files come are exclusive to the Swiss Pattern group.

Because of the great demand for speed in wartime production, files are likely to be looked upon as "expendable"—to be discarded at the first sign of wear. Normally, however, by taking a few simple precautions—each involving but a few seconds—the life of a file can be greatly prolonged.

To keep it in good cutting form, apply the file only to the material for which it is intended, use the recommended stroke, and store the tool in a file rack whenever it is not in use. Because they are brittle and their cutting edges are exposed, files are easily damaged by rough, careless handling. Premature dulling of the teeth is likely to be caused either by filing too fast or using too little pressure on the work. Experts suggest a slow, uniform stroke, with just enough pressure that the teeth do not become glazed from sliding over the work. Except on soft metals, a file should not be dragged over the work on the return stroke. As it is designed to cut when moving forward, dragging blunts the edges. Periodic oiling will add to the file's life, and wrapping it in a newspaper when it is being carried is well worth the trouble.

Stripped teeth are likely to result from using too much pressure, from filing work that "chatters" because it is not held in a vise, from a fast, choppy stroke, or by using too coarse a file for the work. Clogged

teeth can be remedied by using a file card or a soft steel pick, after which the tool should be washed in a hot solution of washing soda and thoroughly oiled. For soft metals, which tend to stick to a file's teeth, use tools with widely spaced teeth, chalk the teeth before starting, and drag the file slightly on the return stroke to clear the teeth.

Files should never be dropped haphazardly on a bench, nor should they be kept loose in a drawer along with other tools. The cutting edges of a new file are as fragile as the edge of a razor, and can be easily chipped through mishandling.

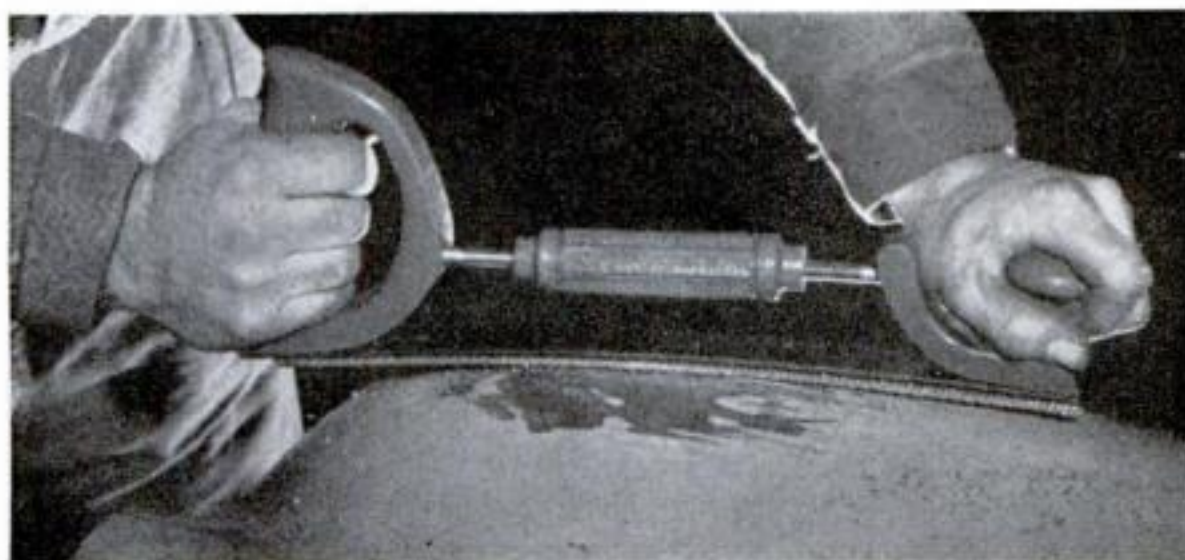
A good trick adopted by expert mechanics to get the best and longest service from files

is to reserve new ones for use on the softer metals, such as copper and aluminum, before beginning to use them on harder metals. In any case, it is a good plan to stick a square of adhesive tape on the heel of each file and mark it to show the type of metal on which the file is to be used.

Under no circumstances should a file be struck against a vise or other object in an effort to clear the gullets. That is the quickest way to break the teeth, the file, or both.

Be sure that the tang of a file is firmly set, so as to avoid breakage and insure accurate work. If the handle is loose, hold the blade of the file in one hand, free of any other support, and tap the end of the handle with a mallet.

SPECIAL FILES DO SPECIAL JOBS FOR VICTORY

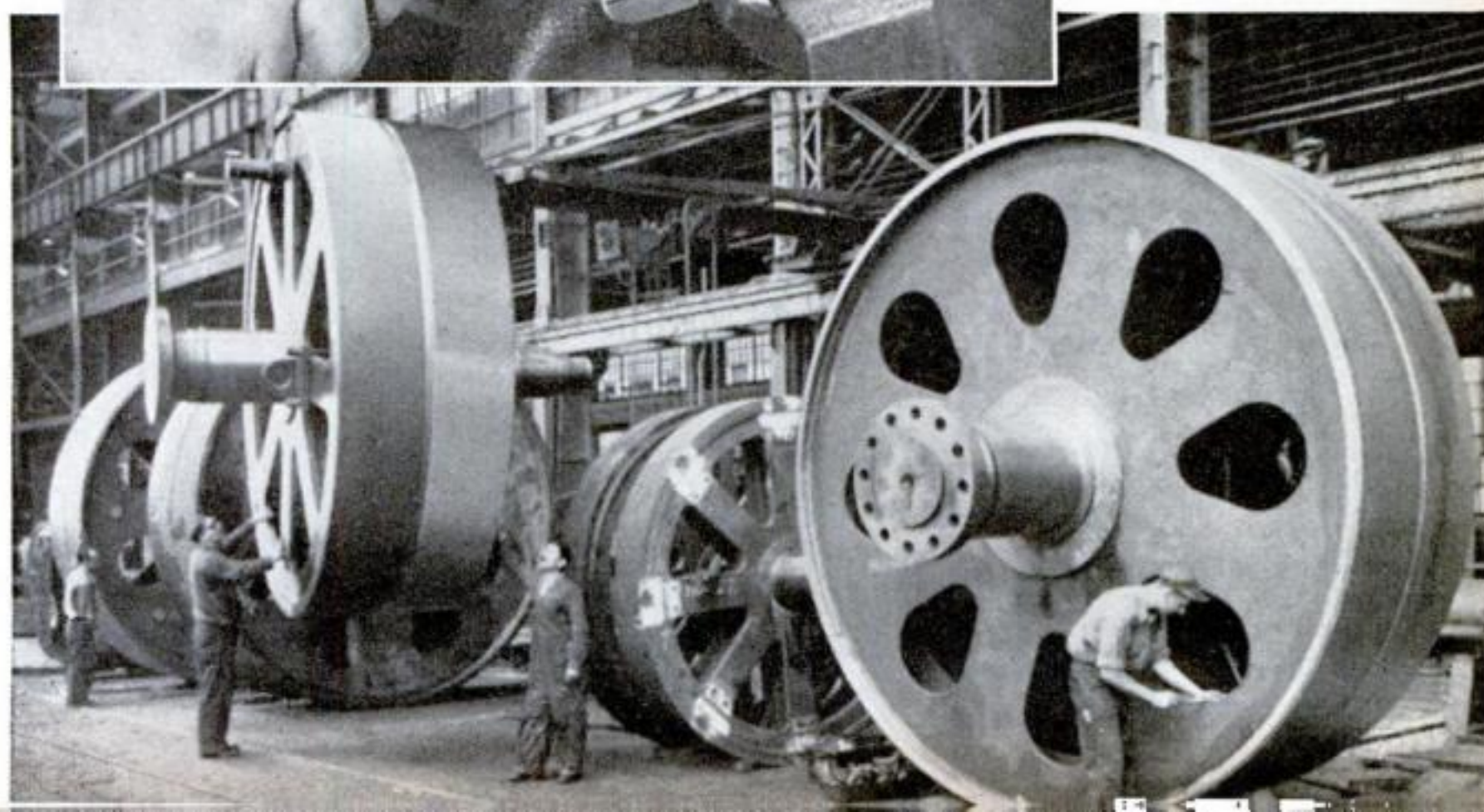


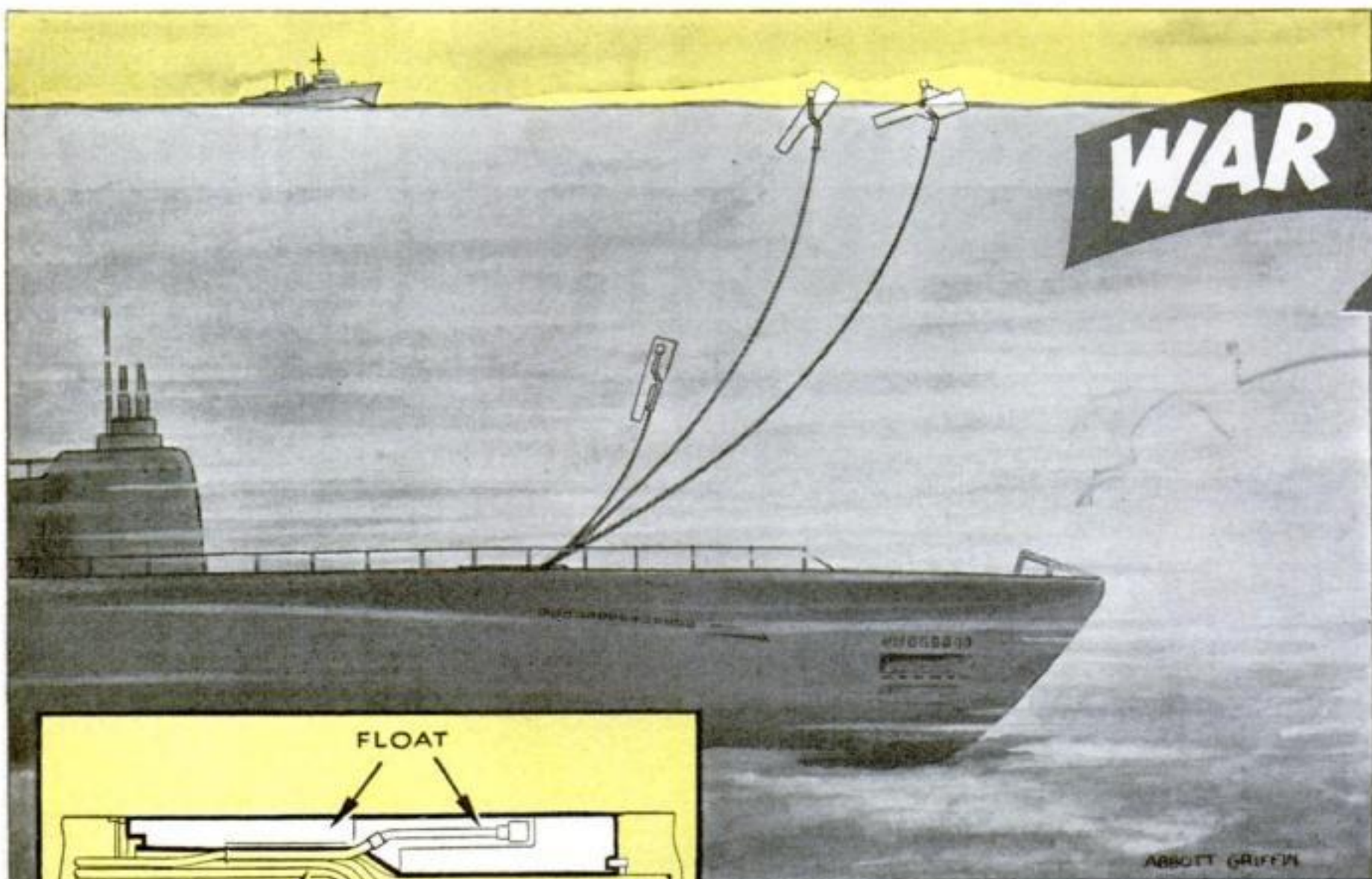
Curved-tooth files, comparative newcomers in the field and originally designed for work on curved auto parts, as shown at left, are now performing the same job on airplanes. Held in a special holder, these flexible files can conform to concave, convex, and also level surfaces



A half-round file smooths the inner surface of a collector ring used in electric motors and generators made by Westinghouse Electric & Manufacturing Co.

Files are also vital to the building of these gigantic marine turbine "bull gears," which, although 13 feet in diameter, must be constructed with watchlike precision



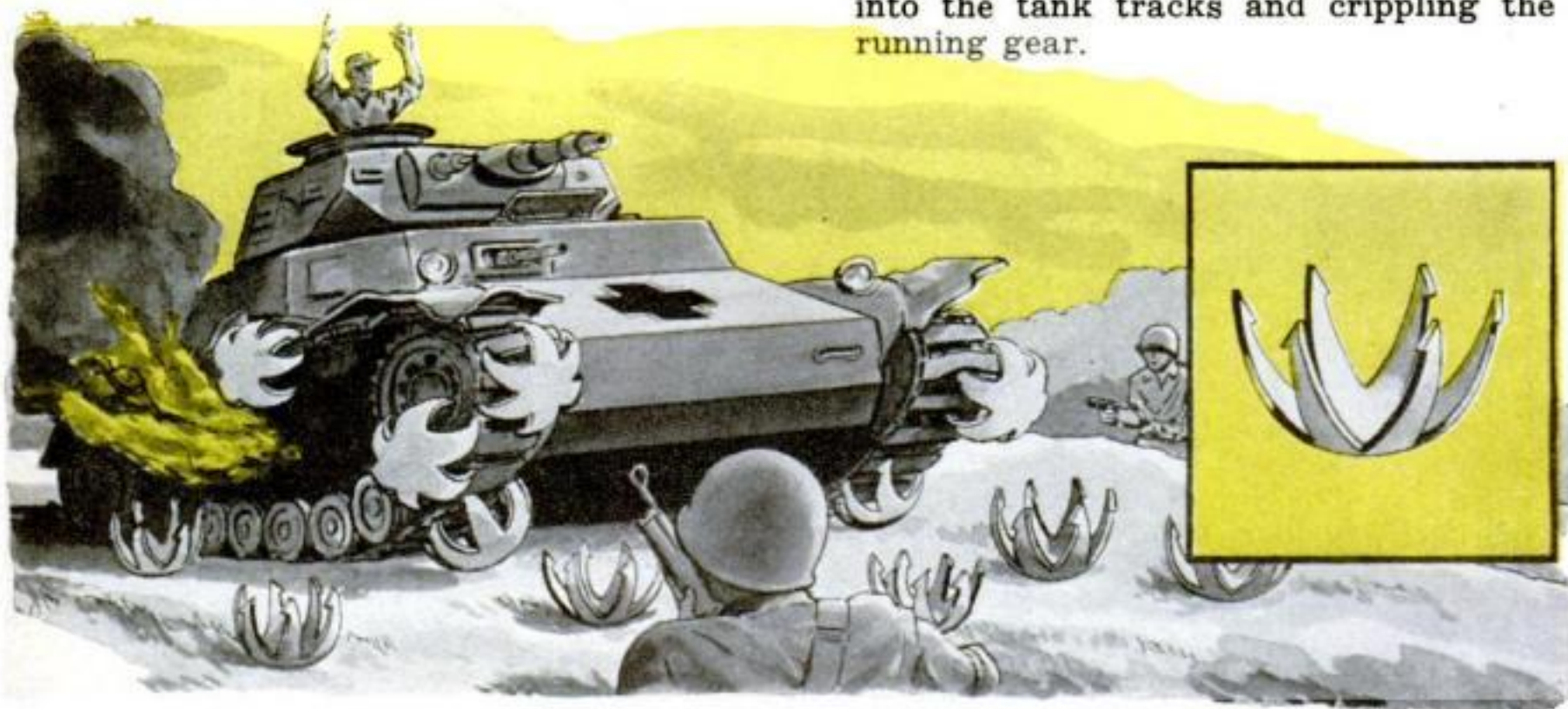


SUBMARINES CAN BREATHE with this air-supply conduit invented by Frederick Gray, of Cheltenham, England. Occupants of the submerged vessel can release the apparatus when it would be too dangerous to surface the craft.

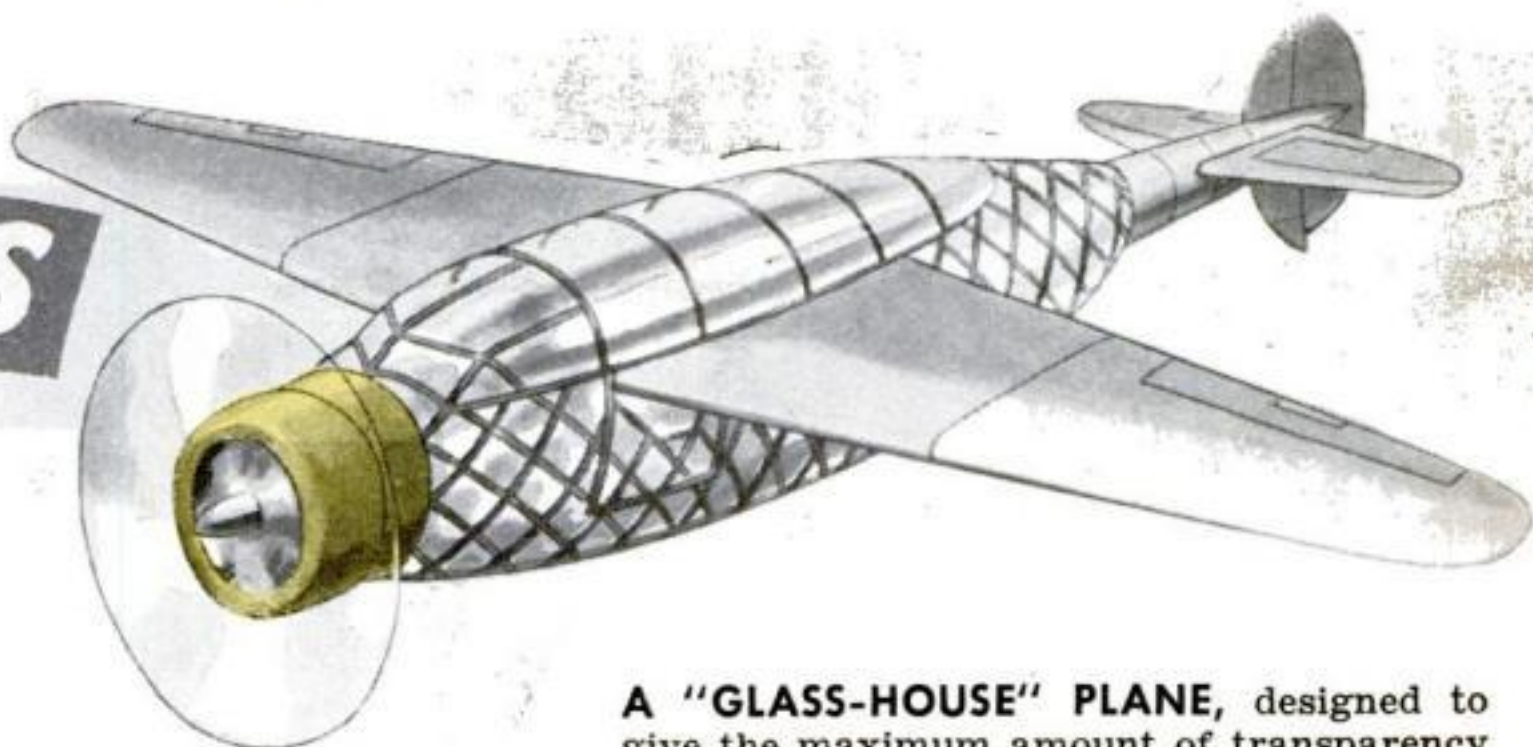
The device consists of a flexible hose attached to a float which rises to the surface when the conduit is set free. In addition to providing an air line, the apparatus might be used as a means of indicating the location of a submarine trapped on the ocean floor, or even afford a means of communication with the crew from rescue vessels on the surface.

CALTROPS, spiky steel stars which were strewn on ancient battlefields to impede cavalry, have a modern counterpart in a device proposed by William J. McDonald, of Kansas City, Mo., for use against tanks. Cuplike stars,

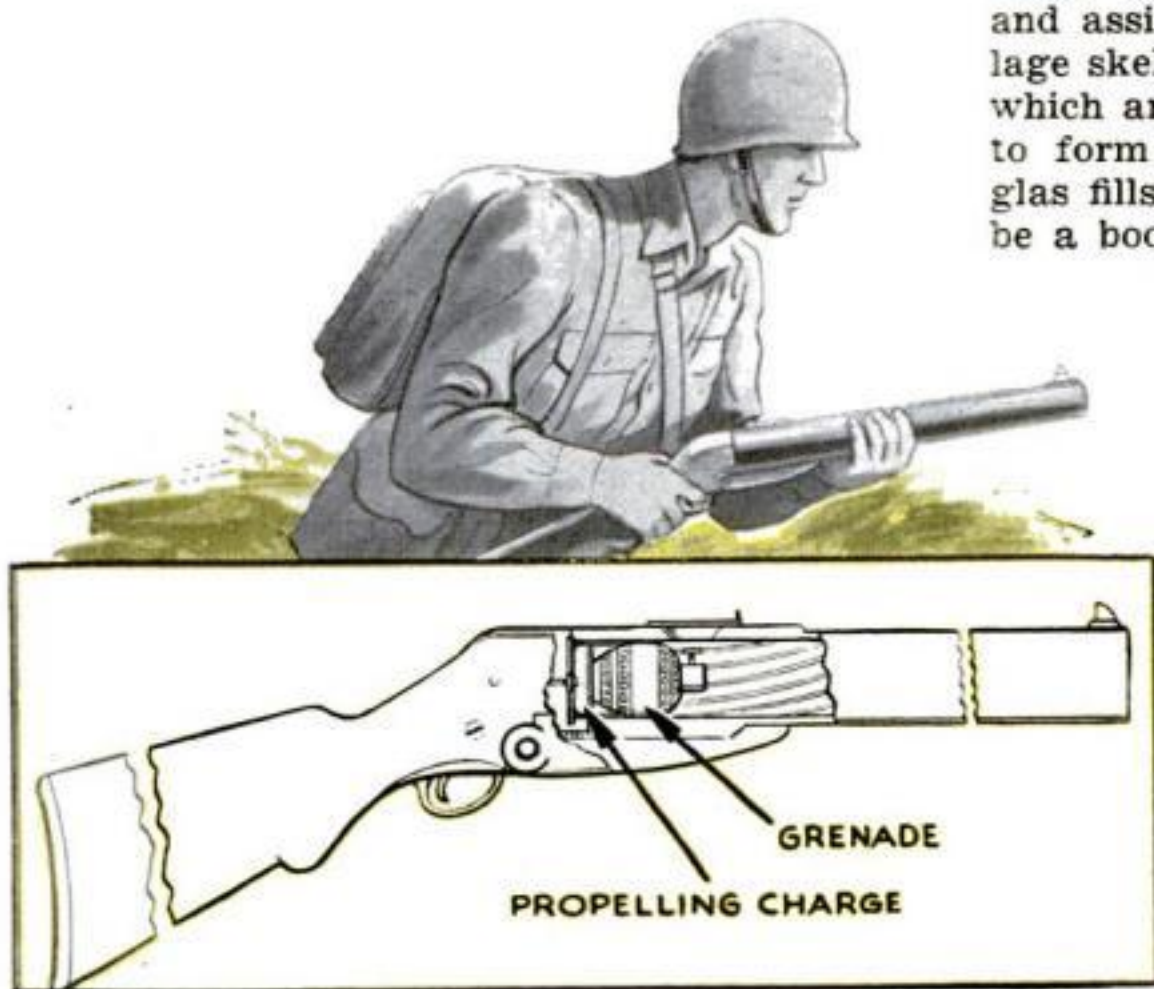
each having six barbed points, would be stamped from heavy steel sheets or plates. Planted in the path of enemy tanks, they would rock on their curved bottoms when rolled upon, jamming their barbed spikes into the tank tracks and crippling the running gear.



IDEAS

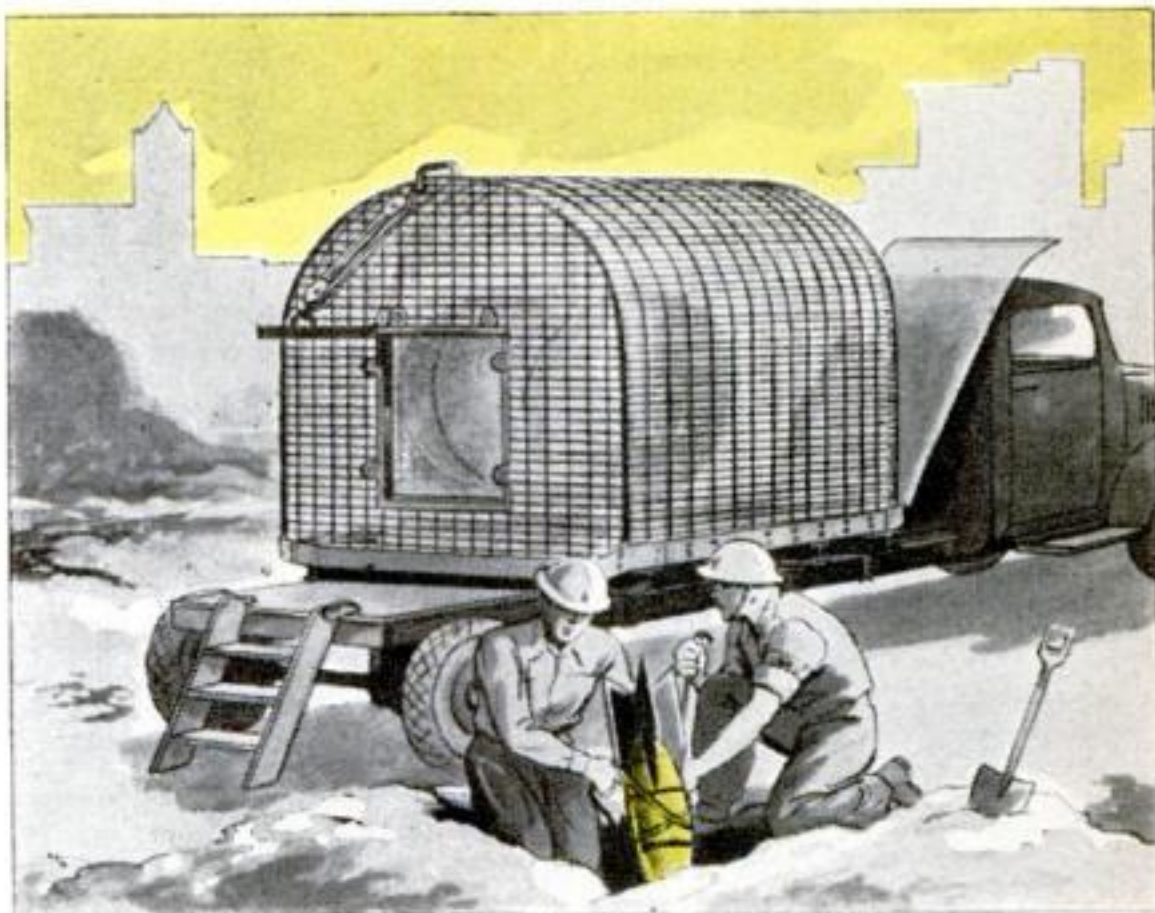


A "GLASS-HOUSE" PLANE, designed to give the maximum amount of transparency compatible with good design, has been patented by R. W. Palmer, of Whittier, Cal., and assigned to Vultee Aircraft. Its fuselage skeleton is a framework of metal ribs, which are arranged in a crisscross pattern to form diagonally spaced panels. Plexiglas fills in the openings. The plane would be a boon to photographers and observers.



A GRENADE GUN, looking very much like the blunderbuss of old except for the absence of a flaring muzzle, is the invention of S. D. Long, of Laurel, Md. The weapon is rifled along the bore, which is big enough across to accommodate the average hand grenade. Grenades for the gun are ribbed to take the grooves along the bore, imparting greater accuracy in flight. Propulsion for the grenade is accomplished by a small powder charge.

THIS BOMB-REMOVER is the brainchild of Fiorello H. LaGuardia, New York's mayor; Thomas Rochester, of Tuckahoe; Hyman Barron, of Laurelton; and John Gibala, of Little Neck, N. Y. Its novel feature is the strong steel-mesh enclosure for housing an unexploded time bomb or other infernal machine, so that a premature explosion will cause little damage. Spherical inner and outer explosion chambers are provided, as well as a support for the explosive at the center of the container. The apparatus was designed to cut down the pressures of explosive gases, which travel radially.



How Regimental Colors Are Made



Regimental standards like the one above are smaller than "colors" and come with a fringe of tassels. Both types of flags use the same basic pattern, the Great Seal of the U. S., with coats of arms and crests added

WITH almost incredible nicety of detail, a staff of 100 skilled embroiderers, working in two shifts at the Philadelphia Depot of the Army Quartermaster Corps, is turning out thousands of banners for military units and high officials, from Presidential flags down to regimental colors and troopship ensigns.

Regimental "colors," which are 4½ feet by 5½ feet, are made of wool unless silk is prescribed, are never adorned with tassels, and are carried by unmounted units on drills, marches, and other service. Tasseled regimental "standards," measuring three by four feet, are carried by mounted and motorized units. All ornamental colors and standards employ the same basic pattern—a modification of the Great Seal of the United States with an eagle clutching an olive branch in one talon and a bundle of arrows in the other. If a regiment has a coat of arms and a crest, or badge, the former is woven into the shield before the eagle, and the latter is set above the bird's head. The background color is determined by the branch of the service.

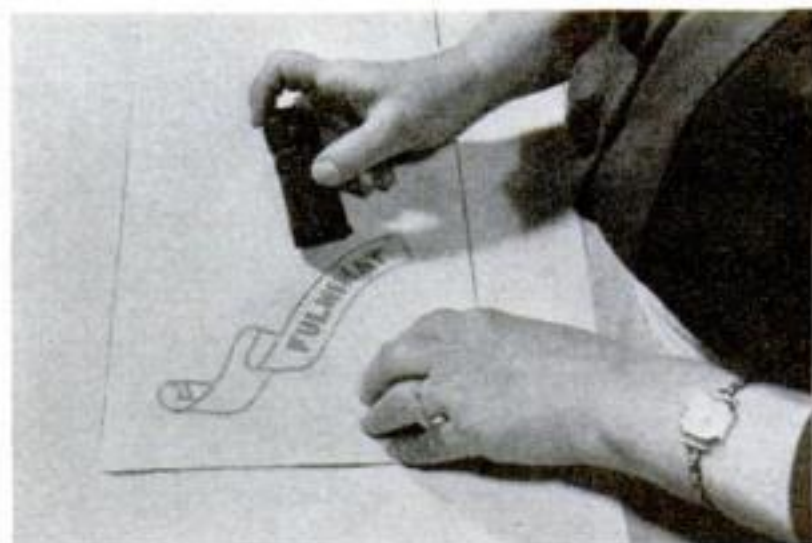
The needleworkers sit at long wooden frames reminiscent of the old-fashioned quilting frame. As the banner is worked, the rollers to which it is attached are turned, so that finished portions are gradually wound back out of the way. Although the work is necessarily of the most meticulous kind, these expert embroiderers can turn out 15 regimental standards a month, as well as dozens of other ornamental flags.



1 With an officially approved water color of an Air Force Bombardment Group coat of arms propped up on her table as a guide, one of the skilled women workers traces its design on paper with tiny holes



2 The finished paper pattern. All other elements that go into the design—the crests, mottoes, scrolls, and eagles—must be outlined on sheets of paper in the same way, then transferred to a silk foundation

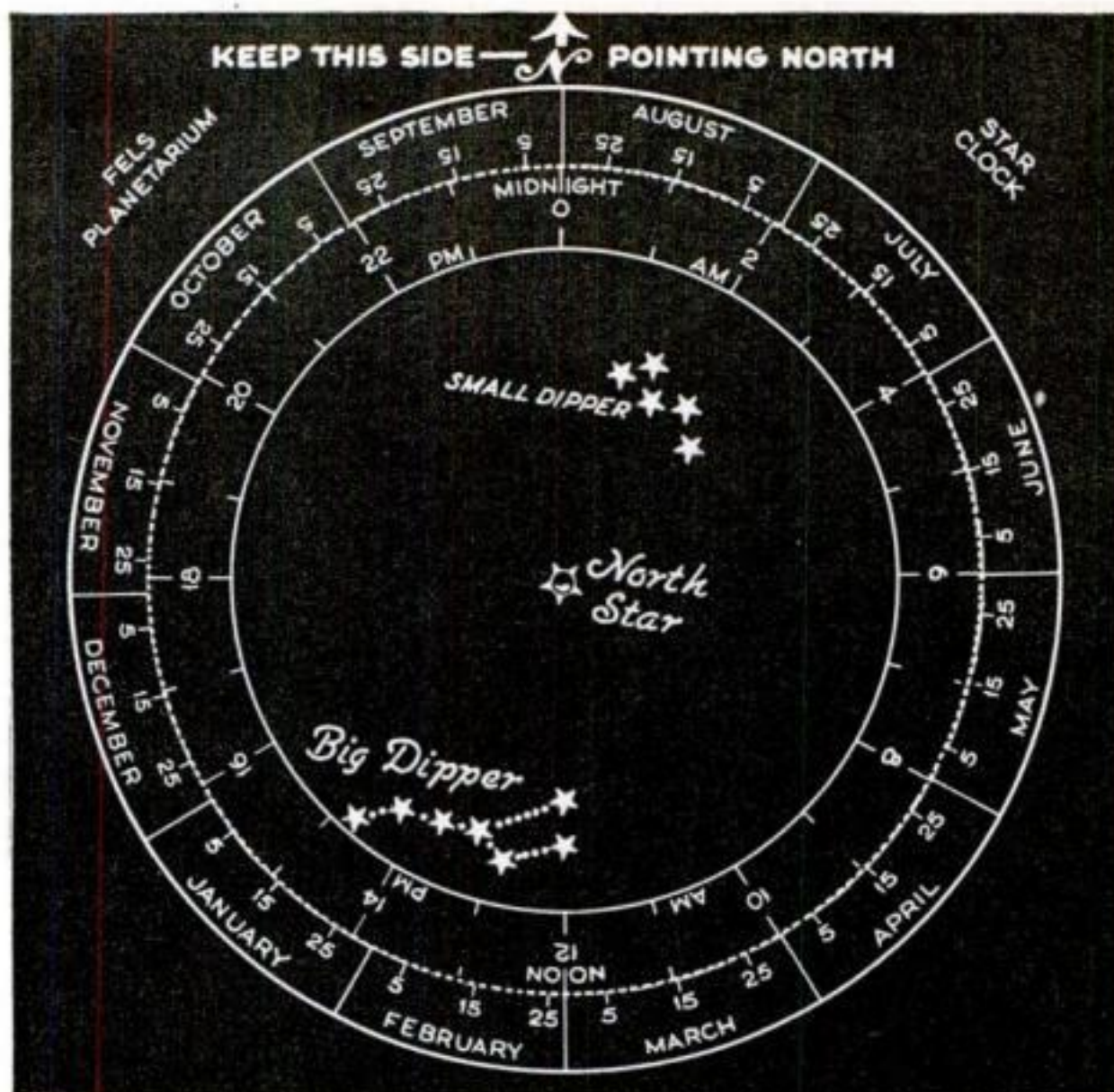


3 Patterns being traced onto a silk sheet by pouncing. Black chalk is sprinkled over the pattern, leaving a series of dots on the cloth, which are connected by pencil to mark position of each individual stitch

4 The embroiderer, leaning over a wooden roller, now stitches the entire design. Using more than 200 colors—30 on the eagle alone—she will work 45 days on a "color," and some 30 days on a standard



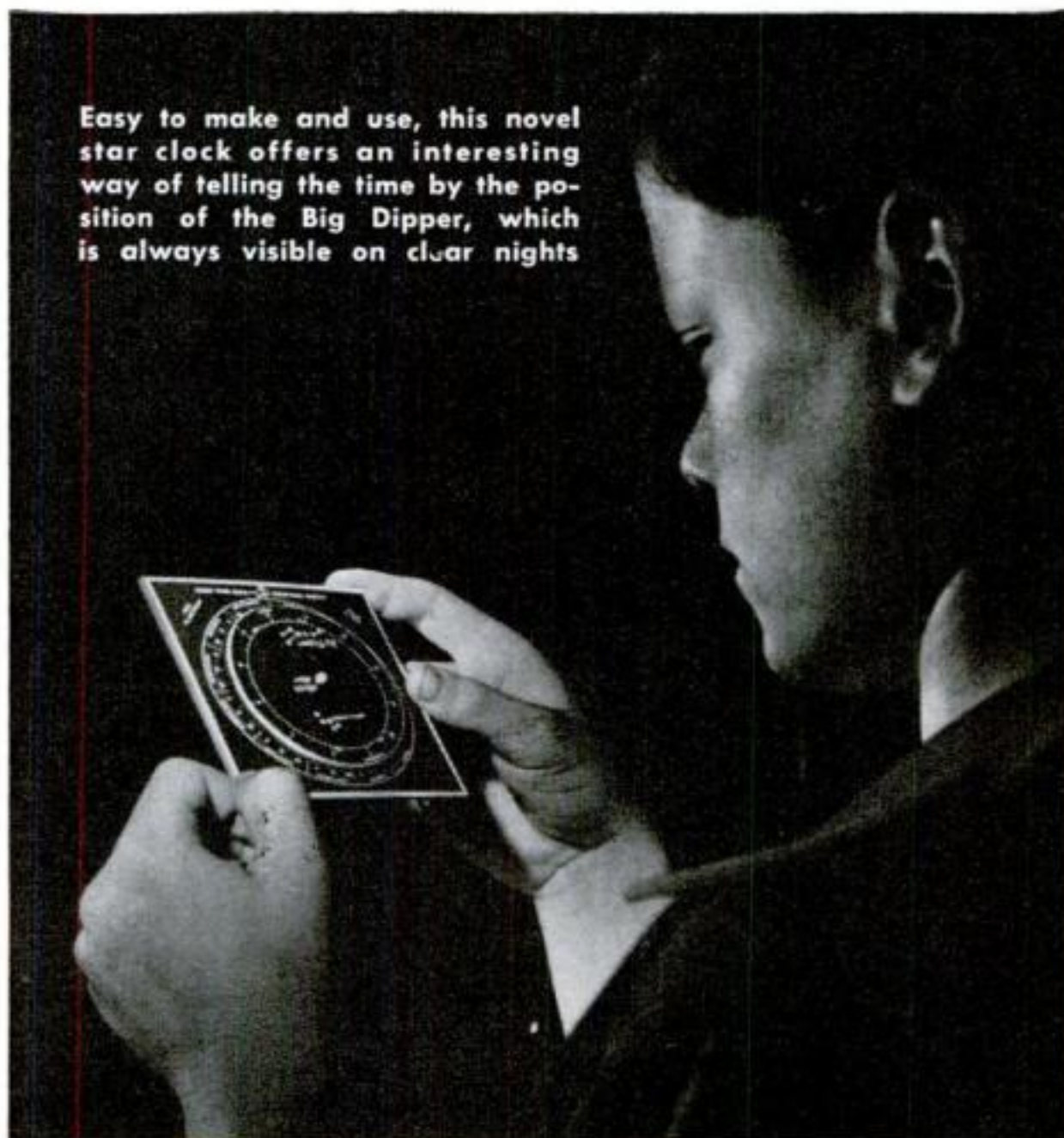
To make this "clock," first cut out of cardboard a disk and a square. Now carefully transfer to the disk the material contained within the dotted circle shown at the right. Then transfer to the square the material appearing outside the dotted circle. To join the two pieces of cardboard, pass a pin or a dressmaker's snap through the center of each, making sure disk is attached loosely enough to revolve easily



Star Clock Tells Time from Big Dipper

A CARDBOARD device for telling the time of night by the stars—a "clock" simple enough to be used by any 10-year-old youngster—has been designed by Dr. Roy K. Marshall, of the Fels Planetarium, Philadelphia. Facing directly north, the time seeker holds the card with its marked edge uppermost and horizontal. He then turns the revolving disk until the position of the Big Dipper as represented upon it corresponds with that of the actual constellation overhead. By locating on the outer circle the point that represents the current date, the hour of the night can then be read from the inner circle within a margin of error of only a few minutes.

Easy to make and use, this novel star clock offers an interesting way of telling the time by the position of the Big Dipper, which is always visible on clear nights



Detailed captions published by the Germans along with this picture warn the Allies that a European invasion will encounter mine fields (offshore), barbed-wire entanglements (2), and then finally tank traps (3). Additional coastal defenses are "ack-ack" guns (5), airfields (6), and sub bases (7). Defenses (4) and (8) are unidentified

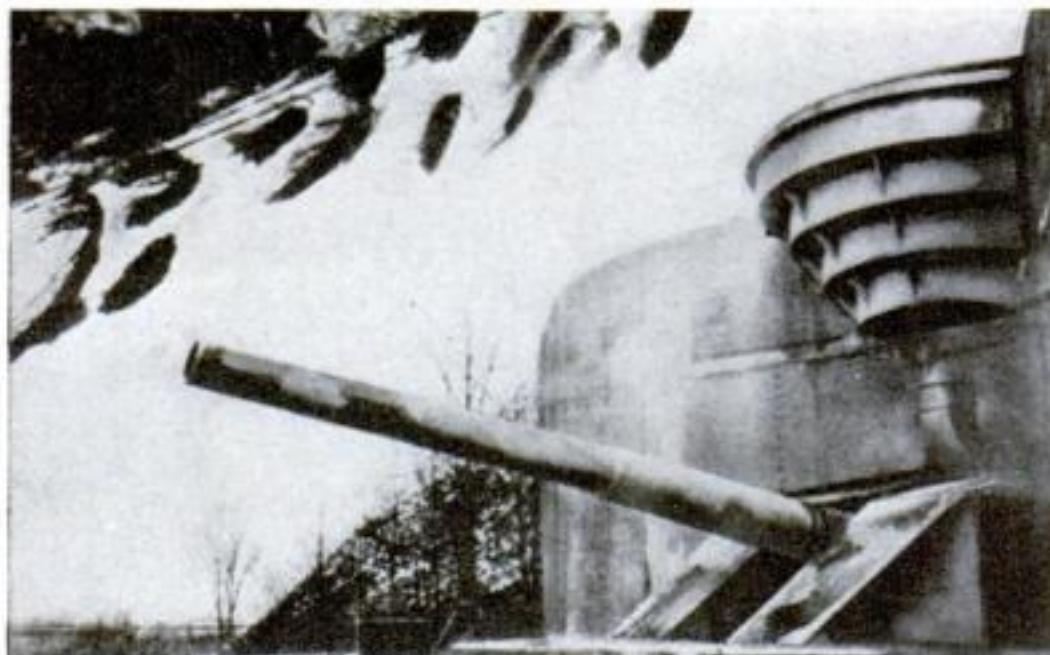
Germans captioned the picture below: "Tank traps. High fortifications of most modern type pinned the enemy down on the strand as early as the retreat from Dieppe"



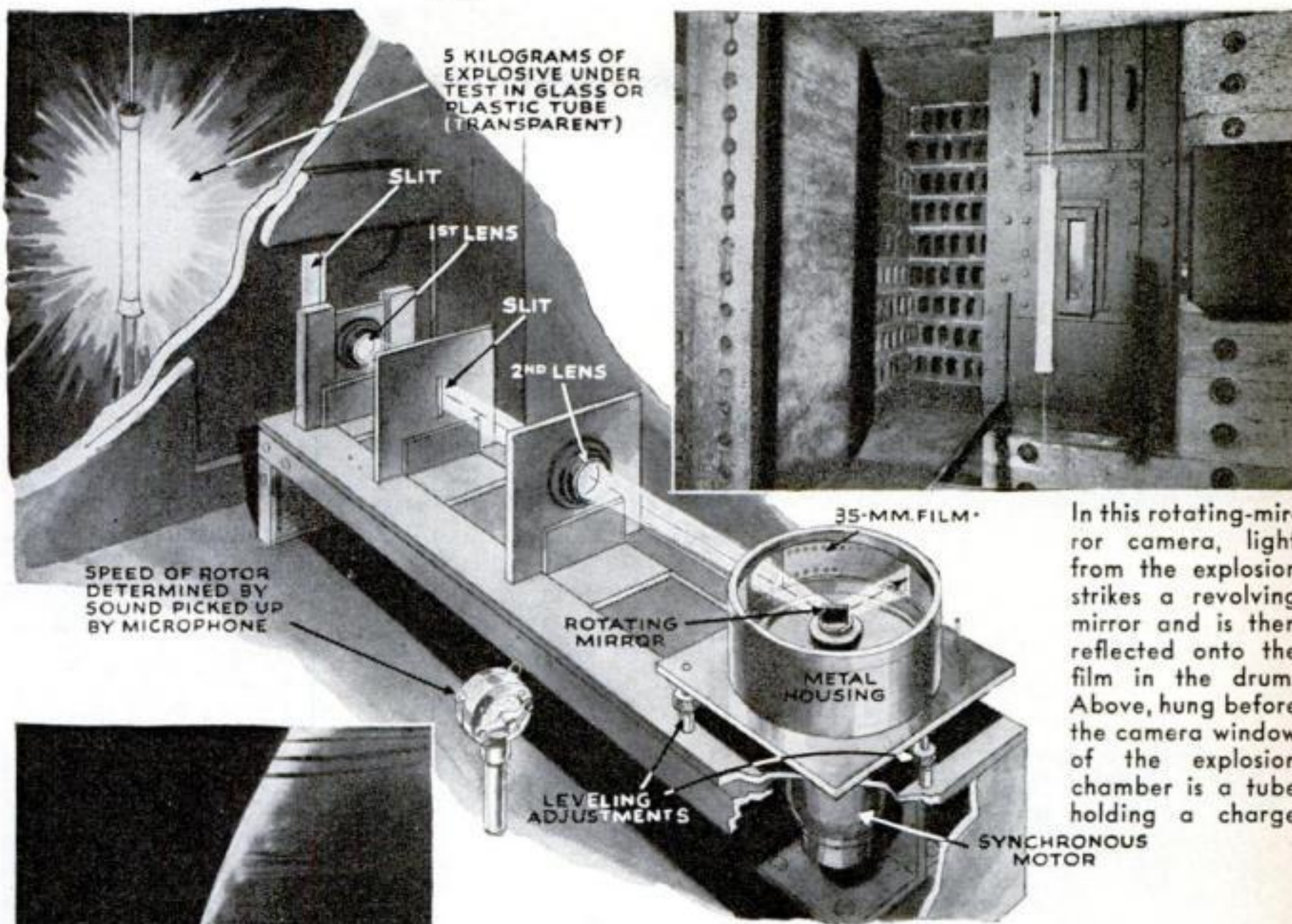
Nazi Pictures Reveal Defense Preparations

THE drawing and photographs on this page, which recently appeared in "Signal," Herr Goebbels' English-language propaganda magazine, are that master mind's idea of an effective counterattack in the war of nerves. With characteristic heavy-handed German subtlety, they were intended to impress Allied readers with the impregnability of Europe's west-coast defenses, and to suggest, of course, that invasion could result only in something approaching national suicide.

To the photo below Goebbels added the warning: "Along the Arctic, Atlantic, and Mediterranean coasts, from Norway . . . to Greece, thousands of these pillboxes have been built"



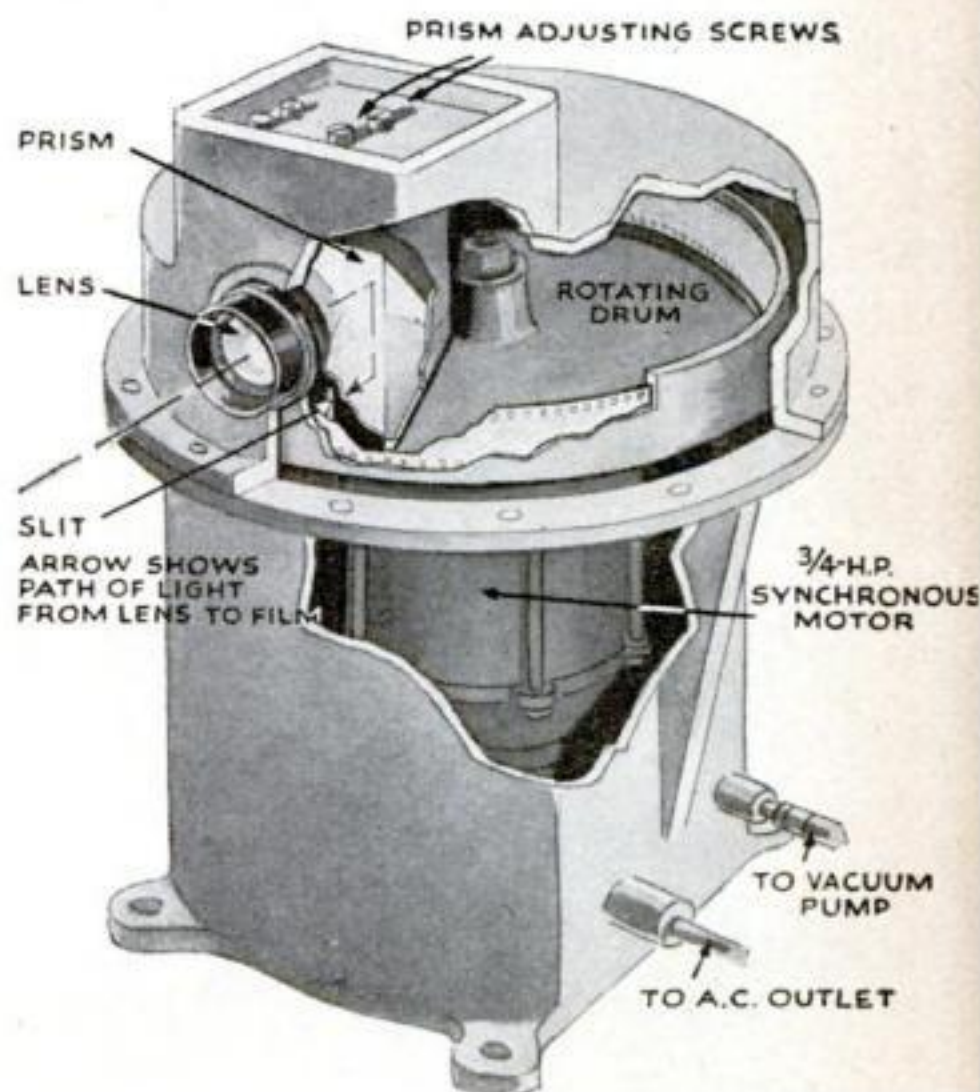
Snapping TNT in Action



In this rotating-mirror camera, light from the explosion strikes a revolving mirror and is then reflected onto the film in the drum. Above, hung before the camera window of the explosion chamber is a tube holding a charge

Camera shows explosions are not simultaneous blasts, but travel from grain to grain up the cartridge. Below: In the rotating-drum camera the film, mounted inside, rotates with the drum

ACTION snaps of TNT are shot by these two cameras, among the fastest in the world. The rotating-mirror camera is ten times faster than the earlier revolving-drum model, although that was swift enough to record the fastest explosive known. Perfected by Dr. Robert W. Cairns, director of the Hercules Powder Company's experiment station, Wilmington, Del., both cameras are used there to record detonation waves traveling five to 25 times as fast as sound. In a specially built explosion chamber a charge in a glass tube is hung near an opening facing the camera and detonated by remote control. From the film experts later study what has happened at every instant of the explosion, even to one ten-millionth of a second. This study of the behavior of explosives is invaluable in determining which is best for each job, from coal mining to blowing up a ship.



POTTERY



Photos by Te Ata, Clyde Fisher, Harold Kellogg, and American Museum of Natural History, courtesy of Natural History Magazine.

ter's wheel to America. Indians still form their pottery entirely by hand, of coils of wet clay, each exactly long enough to reach around its section of the jar.

Among the best Indian pottery is the celebrated black ware of the Pueblos of San Ildefonso, N. M., examples of which are on exhibition in many museums. It has a sheen like that of black lacquer, and the designs are rendered in a soft, frosted surface. Most famous, perhaps, of the pottery makers of San Ildefonso are Marie Martinez and her late husband, Julian, of whom these pictures were made in the San Ildefonso pueblo. Marie makes the pots and, until his recent death, Julian decorated them. The designs are in many cases adapted from those of the old Basket Makers, who preceded the Pueblos.

POTTERY making is one of the oldest American handicrafts. The Indians made vessels of native clay long before the white man came, and among agricultural tribes, like the Pueblos of our Southwest, the art was highly developed. Neither their designs nor their technique changed when the white man brought European culture and the pot-



MOLDING

When the clay is found, the Pueblos devoutly sprinkle blue-corn meal over the bed. After it has been pulverized and winnowed, the clay is mixed with fine sandstone and water, and kneaded (1) to the proper consistency. On the base of the jar, made like a mud pie, coils of wet clay (2), each pinched off to exact length without measuring, are laid atop one another (3), and shaped finally with a gourd spoon. Molding takes about eight minutes; then the jar is sun-dried. For luster, a thin clay paste is brushed on (4) and the surface polished



MAKING...INDIAN STYLE



PAINTING

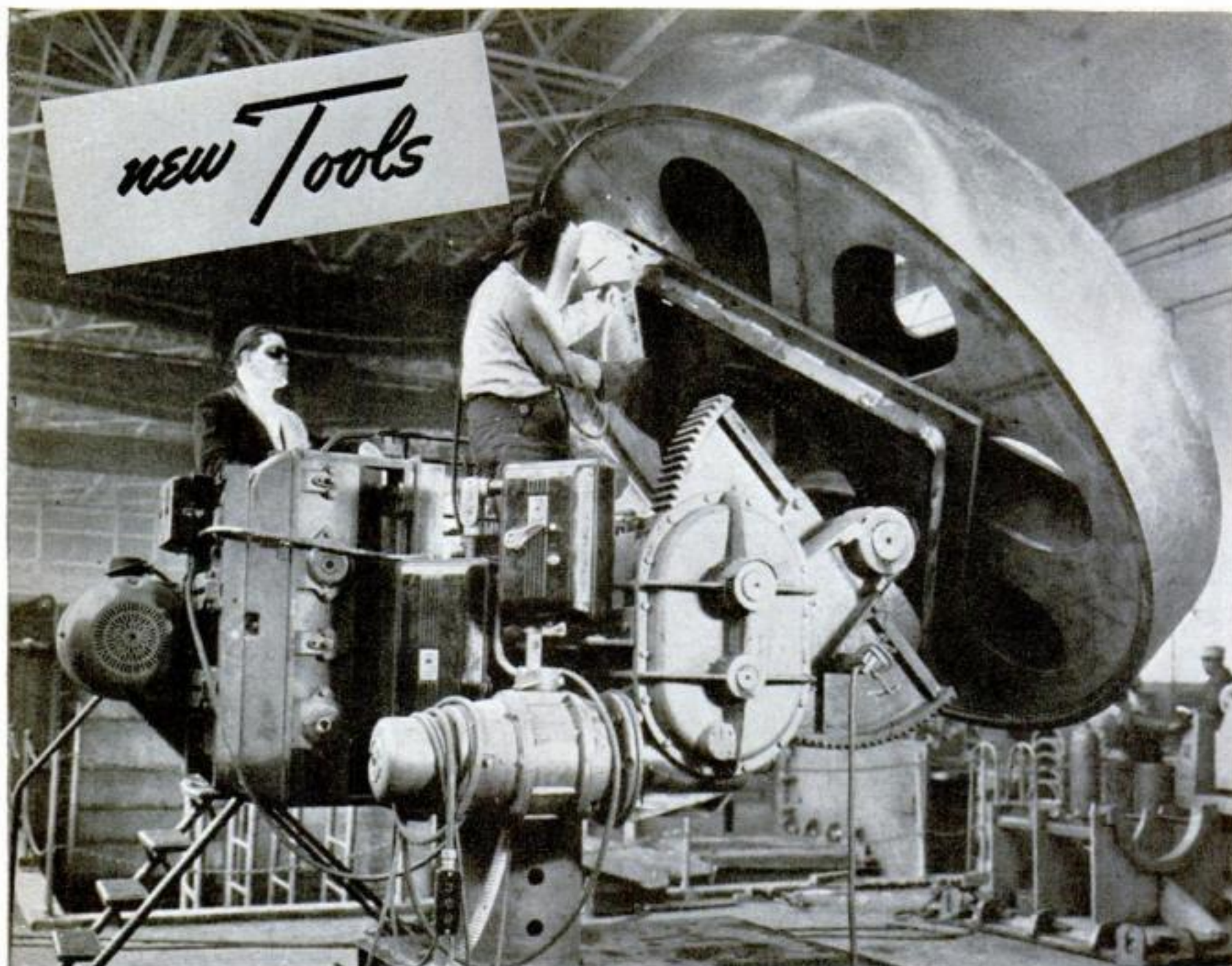
A watery paste of white earth and plant gum is used for decorating; brushes are made of yucca leaves (5). The designs, sketched in freehand (6) always come out even. After the firing process, this white pattern will appear as a soft, frosted finish, and the red body will have become a shiny black



FIRING

Forty or 50 pieces are placed on a grill for firing (7). Metal sheets protect the jars from contact with the fuel, dried dung, which is piled over them (8). Set with cedar bark, the fire burns vigorously for 20 minutes (9). Banking with fine fuel drives thick smoke into the clay, and the carbon imparts the high, black finish. The sheets removed, ashes are thrown on the kiln. When cool, the jars are taken out and dusted off (10) to reveal the beautiful luster that has made the pottery of San Ildefonso famous

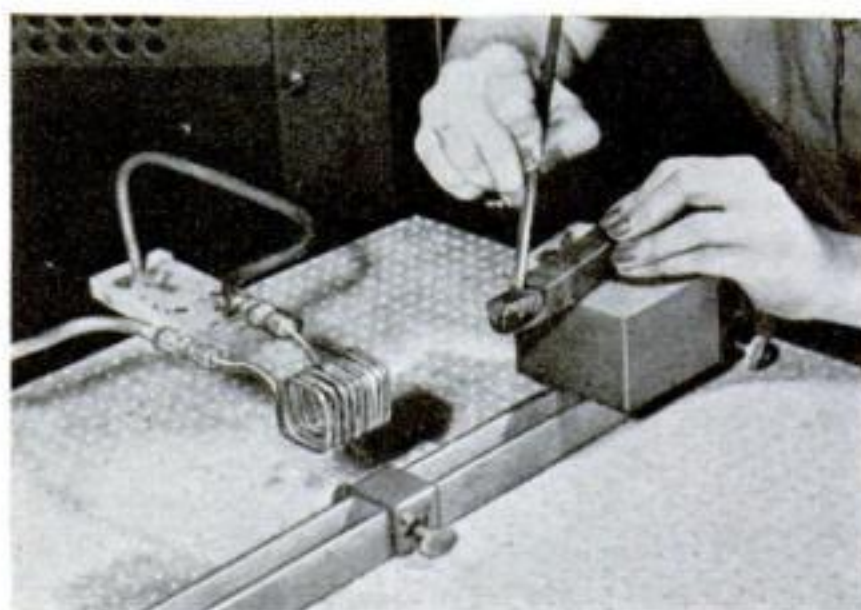
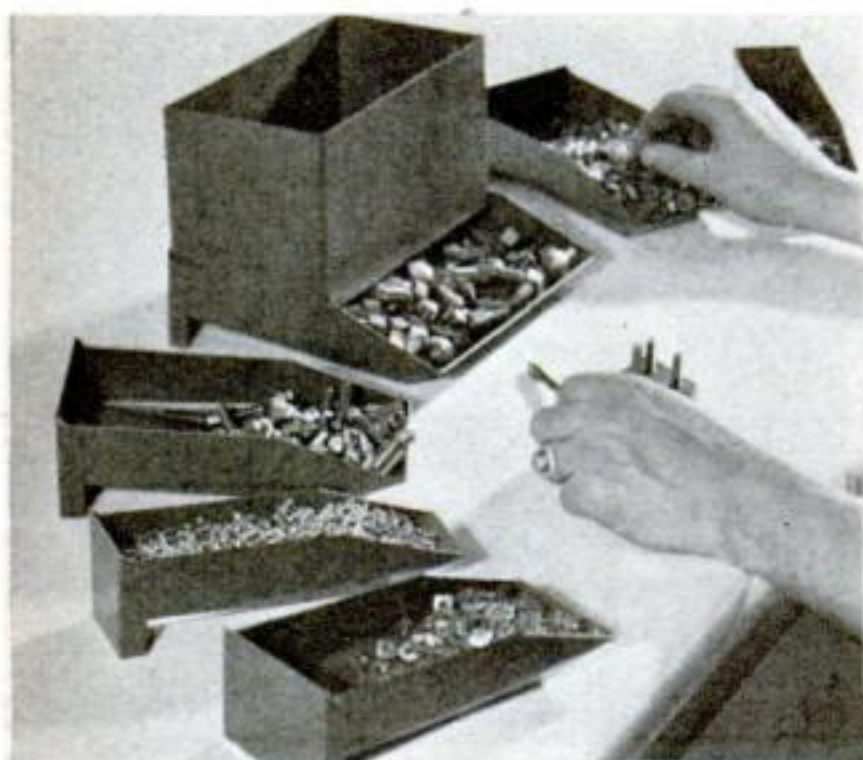




"MANIPULATOR" is the simple name for this machine that holds seven-ton gear blanks in any position for welding. By shifting parts to be welded so the operator will be above them, all welds can be made down-

ward. This is much faster than overhead welding, and it can be done by men with less experience. Westinghouse employs this machine to speed the production of power-transmission gears for cargo ships.

WORKBENCH STORAGE BINS made by the Gordon L. Hall Co., of Old Lyme, Conn., save time for assemblers by keeping parts handy. They are made in several sizes to suit various jobs.



ELECTRONIC BRAZING of carbide tools now is possible with new equipment marketed by the Carboloy Co., of Detroit. Based on new General Electric 500,000-cycle electron-tube oscillators and available in five and 15-kilowatt sizes, the equipment features induction coils of several shapes for various kinds of work. Brazing is said to be faster, cleaner, and cheaper this way.



SAILOR BEWARE. HOW HYDRO WARNS SHIPS OF A NEW HAZARD

Road Maps of the Sea

GUIDE OUR FIGHTING SHIPS

By
Alden P. Armagnac

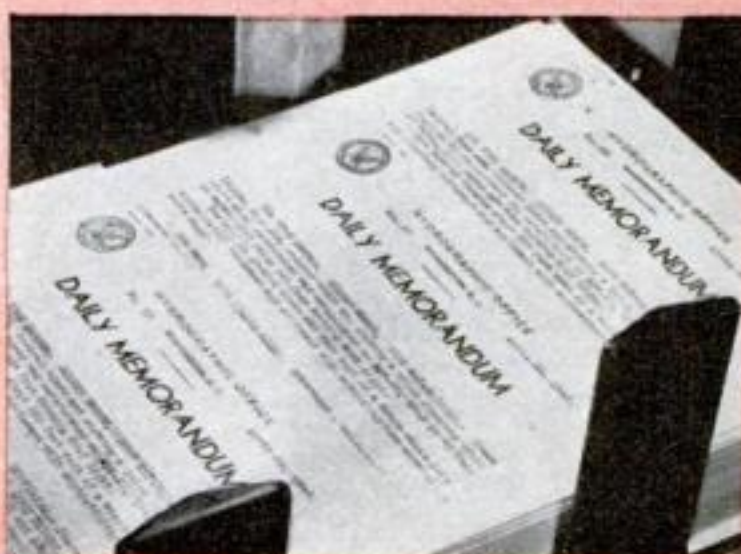
FLAMING from stem to stern, a cargo ship laden with munitions gave New York Harbor several hours of tense excitement one Saturday evening last spring. Police and air-raid wardens spread the alarm along the waterfront to open household and factory windows—and then stay away from them—for fear of a devastating explosion. Crews of fireboats and tugboats risked being blown sky high, until the ship was towed to a remote spot and scuttled in water deep enough to put out the blaze.

Newspapers headlined the spectacular event. But few knew the behind-the-scenes story that follows all such marine misadventures. The place to find that out is "Hydro"—the Navy's Hydrographic Office at Suitland, Md., which serves as the Government's clearing house for up-to-the-minute maritime information.

Advised of the derelict's position by teletype from official New York headquarters, Hydro relayed details to Washington and Boston radio stations. Shortly the warning went crackling through the ether to vessels at sea on a scheduled "BAMS" program—"Broadcast to Allied Merchant Ships." Next



A warning is prepared for radio broadcast

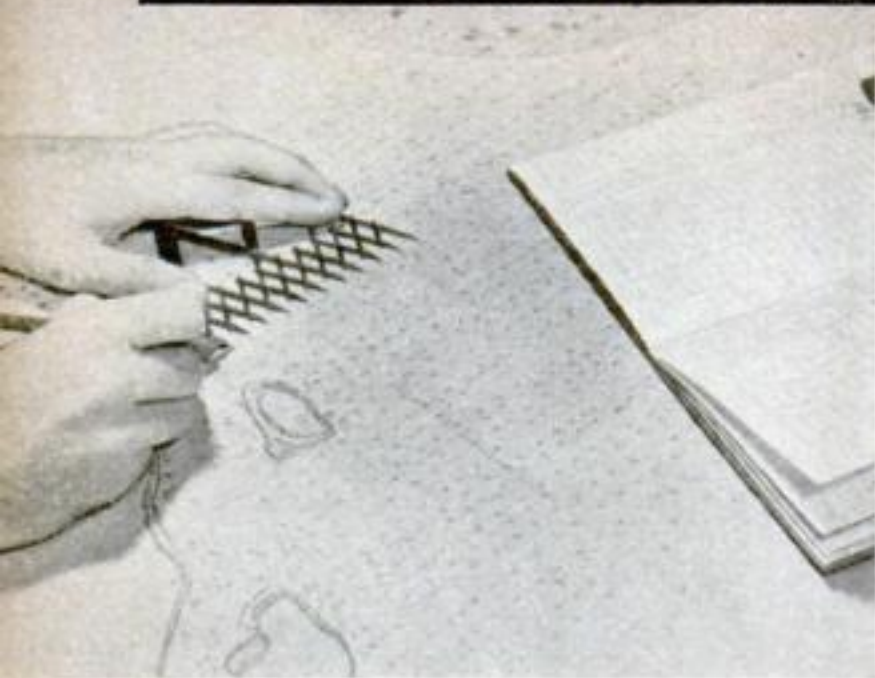


... Notices appear in "Hydro" publications

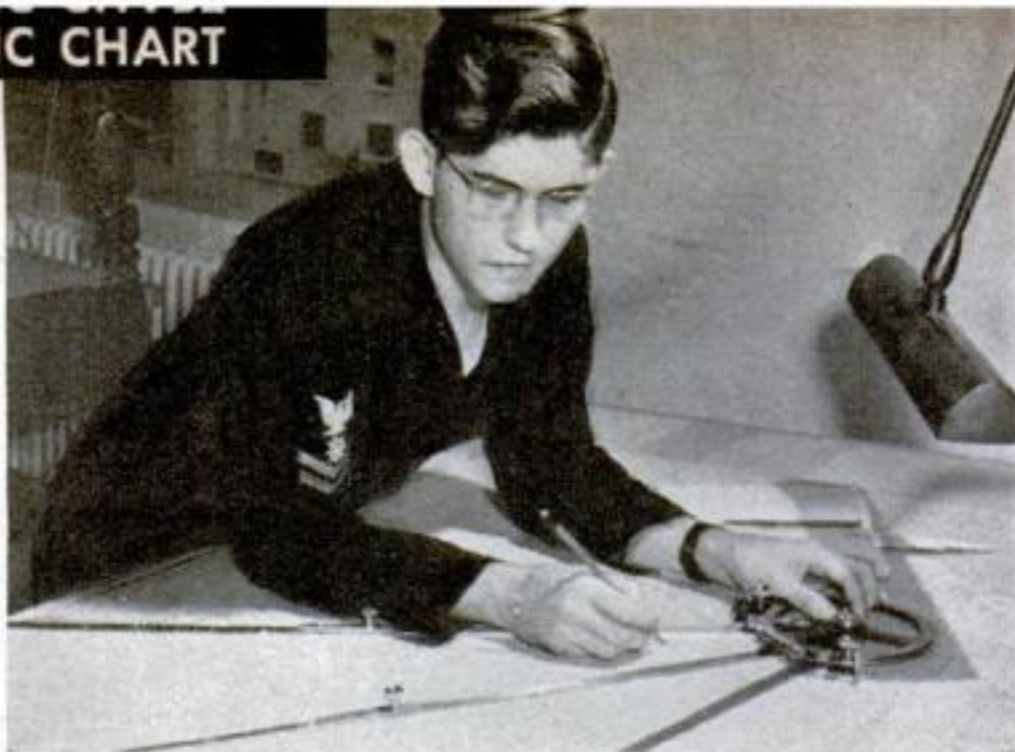


... Symbols are stamped on charts of area

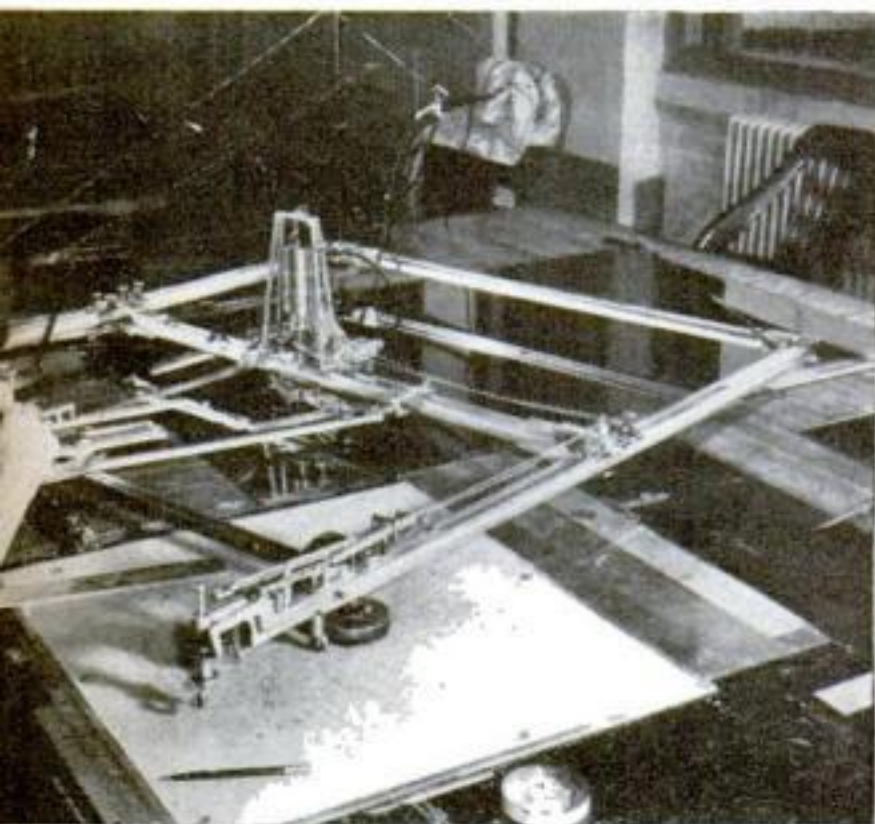
MAKING A HYDROGRAPHIC CHART



1 First step is to make a "boat chart" from the soundings taken by a survey vessel. Soundings were taken at regular intervals from a boat moving at constant speed over a fixed course. The depths are recorded at points shown by dividers



2 After a careful checking to see that it agrees with the survey data, the figures on the boat chart are transferred to a "smooth sheet." Here they are combined with the results of other observations made in the area, to furnish all the information that mariners will need



4 A section of the completed chart is transferred to a part of a large copper plate (in background) by the girl operator of this pantograph, who traces the lines of the original. Templates are used in inserting place names



5 Sprawled across the nearly completed master sheet of copper, an expert craftsman tools in fine lines that represent mountains, reefs, and other topographical features. Painstaking as his work is, a mistake can be corrected by hammering the soft copper upon an anvil

day, substantially the same message appeared in the Hydrographic Office's "Daily Memorandum." It read:

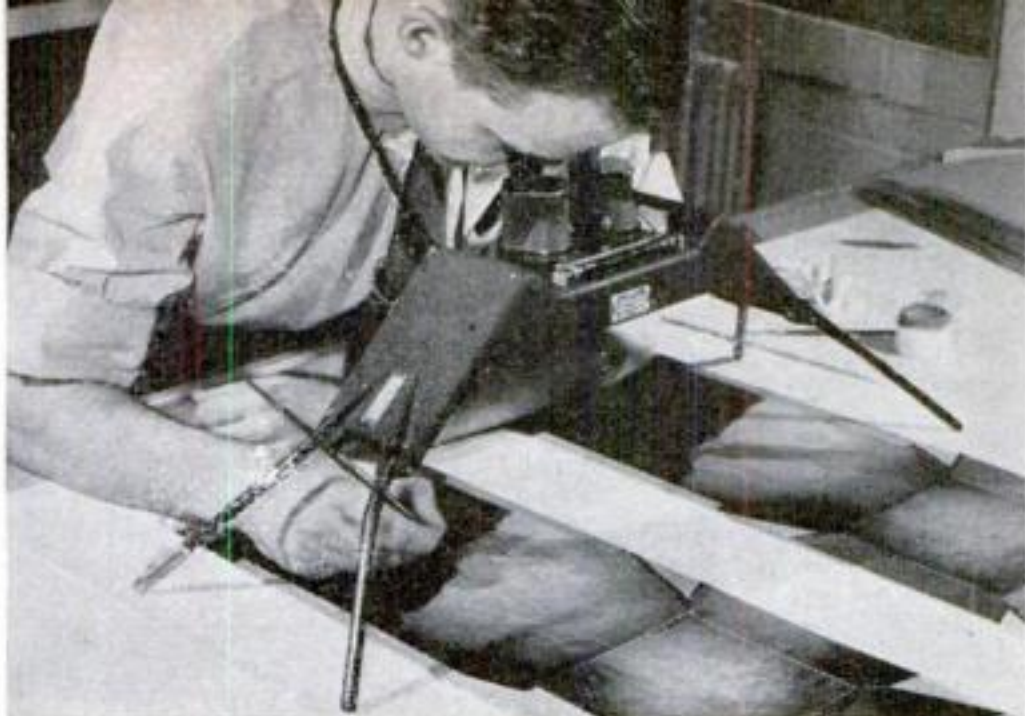
"NEW YORK HARBOR, SUNKEN WRECK, BUOY ESTABLISHED.—Wreck Lighted Buoy 29A, colored black and showing a quick-flashing light of 20 candlepower, was established on April 25, 1943, in 45 feet of water, 1,225 yards 56° from Robbins Reef Light. The buoy is located about 225 feet east of a wreck which lies approximately northwest and southeast with superstructure showing above water." For good measure, the warning also appeared in Hydro's weekly "Notice to Mariners," another of its invaluable publications for seafaring men.

Finally, in case there is no immediate prospect of removal of such a hazard to navigation, official charts of the area are

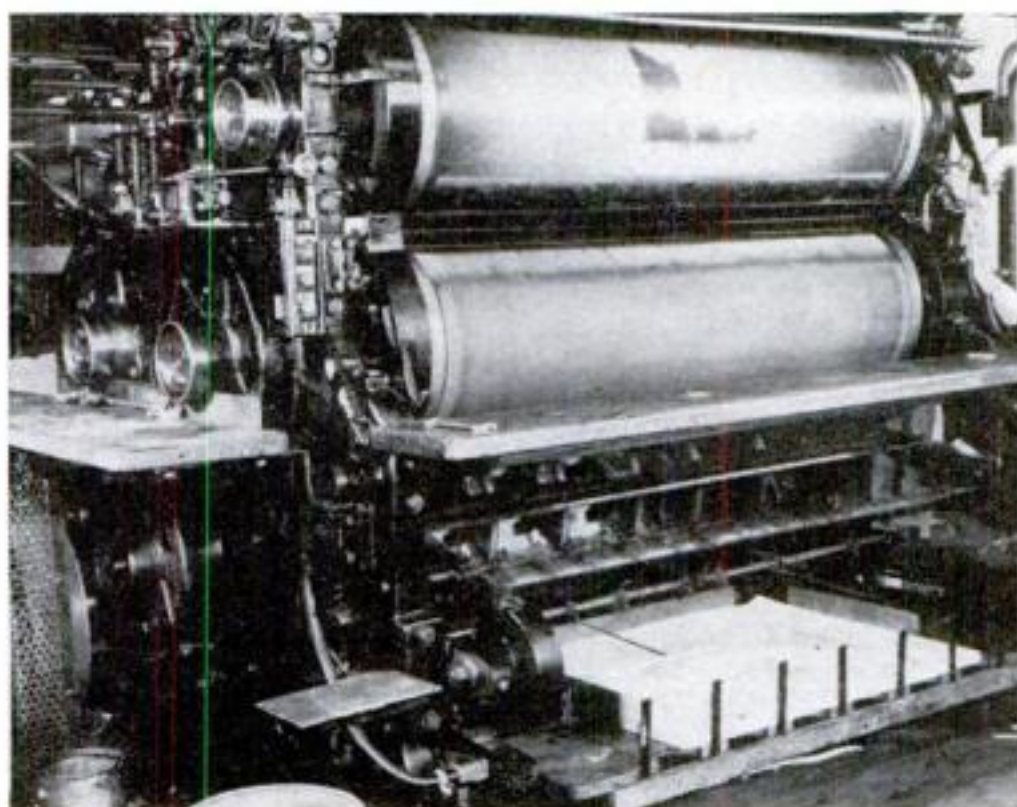
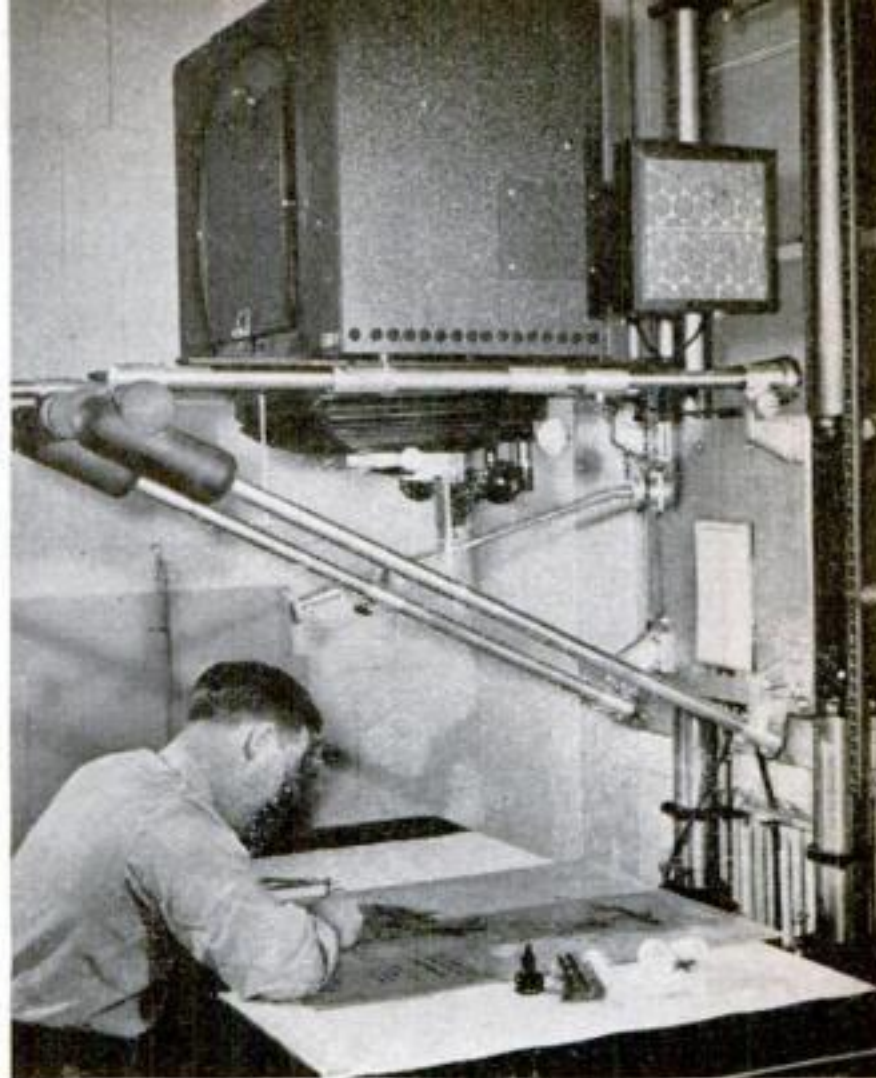
stamped with the necessary correction—which may be a pictorial symbol for a derelict, a lozenge and a sunburst for a lighted buoy, and the letters "Qk Fl G" for quick-flashing green. Newly established lights and other aids to navigation are inserted in similar fashion.

Perhaps this may be getting ahead of the story. Preparing the original charts themselves constitutes one of the most responsible duties of Rear Admiral G. S. Bryan, Hydrographer of the Navy, and of the Hydrographic Office which he heads. For victory in battle and safety in little-known waters, warships and cargo vessels alike depend upon the accuracy of these "road maps of the sea."

Some idea of war demands upon Hydro may be taken from newly available figures.



3 Aerial photographs help locate coast lines, reefs, and inland topography. This stereoscopic instrument shows the height of the terrain. Results of marine and aerial surveys are combined with the aid of the projector at right, which throws an image to the desired scale



6 Off the presses roll the finished charts, printed from zinc plates made from the copper sheets. Hydro now prints more than 2,000,000 charts a month to meet the needs of U. S. warships and United Nations mariners. Meanwhile, Navy survey ships are charting new areas

Charts of all types now pour from the Office's battery of printing presses at the staggering rate of 24,000,000 a year, compared with a mere 500,000 annually for the peak prewar period—an increase of nearly 50 times in production. Revision of out-of-date charts, acquisition of new foreign bases, and new needs for airplane charts are among the reasons. A complete set of Hydro's charts, many of them highly confidential, depicts about 3,000 different areas of the world. Typical of the restricted list, a large-scale chart of New York Harbor includes soundings and buoys; the Hydrographic Office has a single, well-guarded copy. Nonconfidential charts, of equally exquisite workmanship, are available to the general public at cost.

A new "Life Raft Chart" developed by the Hydrographic Office, printed on waterproof fabric instead of paper, goes far toward meeting



7 She's sitting on top of the world—at least a part of it, as depicted by Hydro in charts ready for folding, filing, and mailing. The files in the background fill two large rooms, containing charts of waters throughout the seven seas

suggestions of Capt. Eddie Rickenbacker—rescued after drifting three weeks on a rubber raft at sea. Unlike the paper chart he had, which turned to illegible pulp after a drenching, the fabric type can be rolled into a ball under water—and then smoothed out and read as easily as before. Used as a head covering, it shields the wearer from the burning rays of the tropical sun. It may be used for catching rain water, and, in a pinch, for bailing. Supported by a pair of oars, it even serves as a sail!

The particular chart chosen for this versatile aid, called a "Pilot Chart," covers one of six areas in which the user may be—the North or South Atlantic, the North or South Pacific, the Caribbean Sea, or the Indian Ocean. Within the compact space of 26 by 38 inches, it contains information vital for survival. Especially, it shows a survivor of shipwreck the prevailing wind and ocean currents that will carry him to safety. One island may be near, but hopeless to reach; another farther, but right in the path of a drifting raft.

How do hydrographers find out which way the currents run? One way is to drop bottles in the sea! An [\(Continued on page 210\)](#)



"Bottle papers," thrown overboard from ships at sea in peacetime, help Hydro map ocean currents. Some of them have been returned after drifting 10,000 miles



USED AS A SAIL



... AS A SUNSHADE



... AS A RAIN CATCHER



"LIFE-RAFT CHARTS," printed on waterproof fabric, are a wartime innovation designed to meet the needs of shipwrecked flyers and seamen. Unlike paper charts, which are reduced to illegible pulp by the first drenching, they resist soaking as shown in the test above. In addition to guiding castaways to land or to shipping lanes, they serve other useful purposes



Rollers Give Landing Boat High Speed

A HIGH-SPEED, air-propeller-driven boat that literally rolls over the waves has been proposed by Pietro C. Lombardini, of England. In starting, the boat moves through the water on its hull, but once it attains 50 knots, a series of free-turning rollers, lowered into the water in place of

the hull, reduces the boat's resistance and enables it to increase its speed greatly. The drawing shows an adaptation for beach landings. As a small aircraft carrier, the fast ship would make it possible for planes to take off with a minimum run and to land at high speeds, the inventor claims.

"I AM A TANK-DESTROYER COMMANDER"

By JACK O'BRINE

Photographs by William W. Morris



Sergeant Thurman Horton—and there are thousands like him—has an answer for Axis armor in a hard-hitting M-10 "panther."

OUR new M-10 tank destroyers are dubbed "rolling panthers." Enemy armor is their meat. In a dozen battle sectors, these fast, fierce creatures of steel have left a trail of twisted wreckage—the remains of Axis tanks. They're America's challenge to panzer packs. Behind their record of havoc, you'll find the newest hero of armored warfare—the tank-destroyer commander. He may be a swashbuckling, fire-eating fighter, hell-bent for breakfast. But more likely you'll discover him to be as homespun and unassuming as Sergt. Thurman Horton, 27-year-old commander of a rolling panther in the 630th Tank Destroyer Battalion, 79th Division.

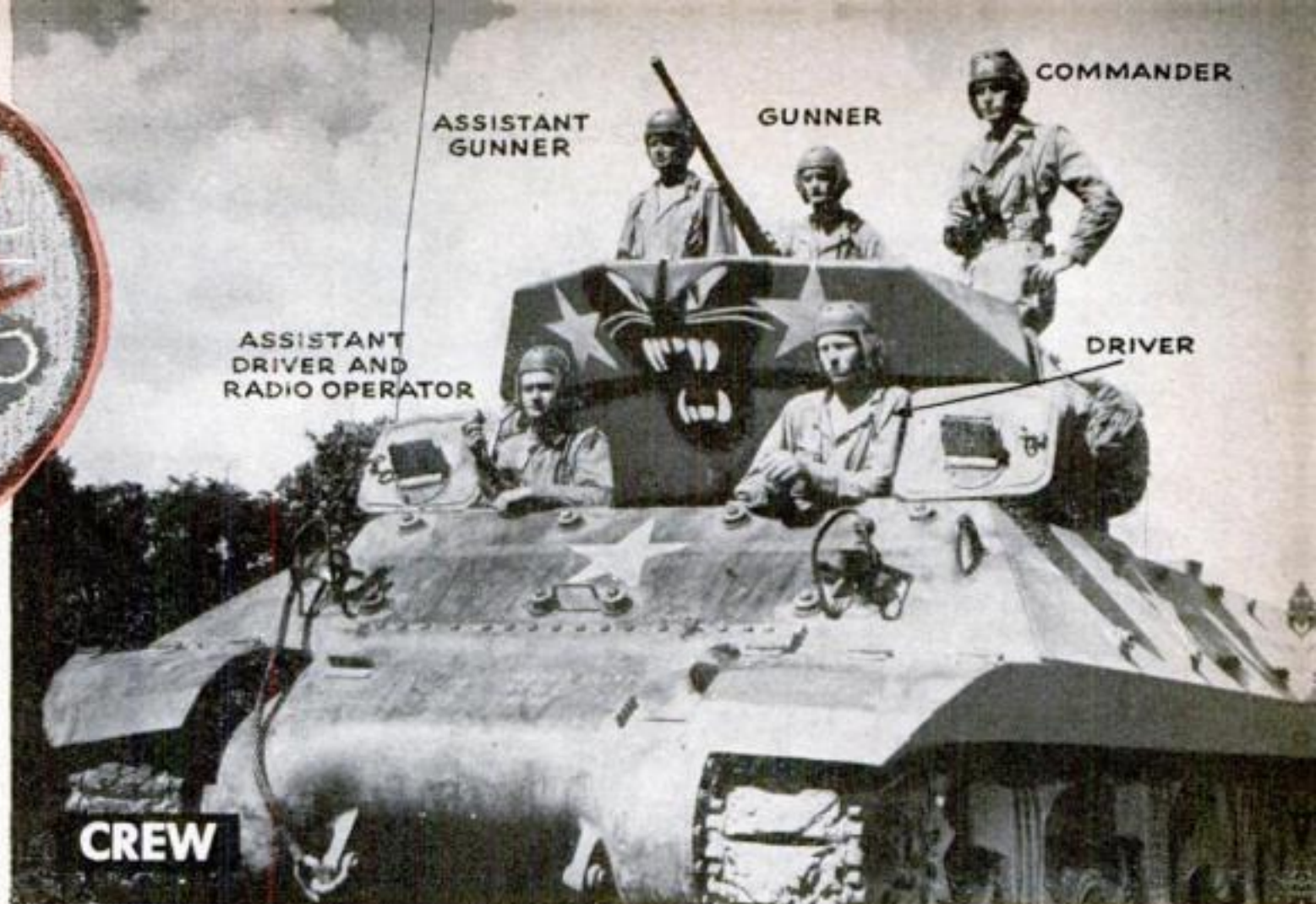
Horton comes from Clarkton, N. C., population 484. He's a lean, quiet-spoken lad who never saw a tank, let alone a destroyer, before he was inducted into the Army. He joined his battalion only last December. But now "Old Man" Horton, as his crew calls him, is a tank-destroyer commander to reckon with. And, for his part, the strapping sergeant makes no bones about his preference for tank busting, as compared with construction work and free-lance commercial art, from which the Army called him. He

Clawing its way out of a wooded ravine, Horton's "panther" proves that it can take the bumps in rough country. With the same chassis as an M-4 medium tank, it has the speed and stamina it needs to ambush its fast-moving panzer prey





The snarling panther face of the TD Force emblem and the motto, "Seek, strike, destroy!" express the spirit of the five-man crew. Each man is a specialist in a smooth-working team

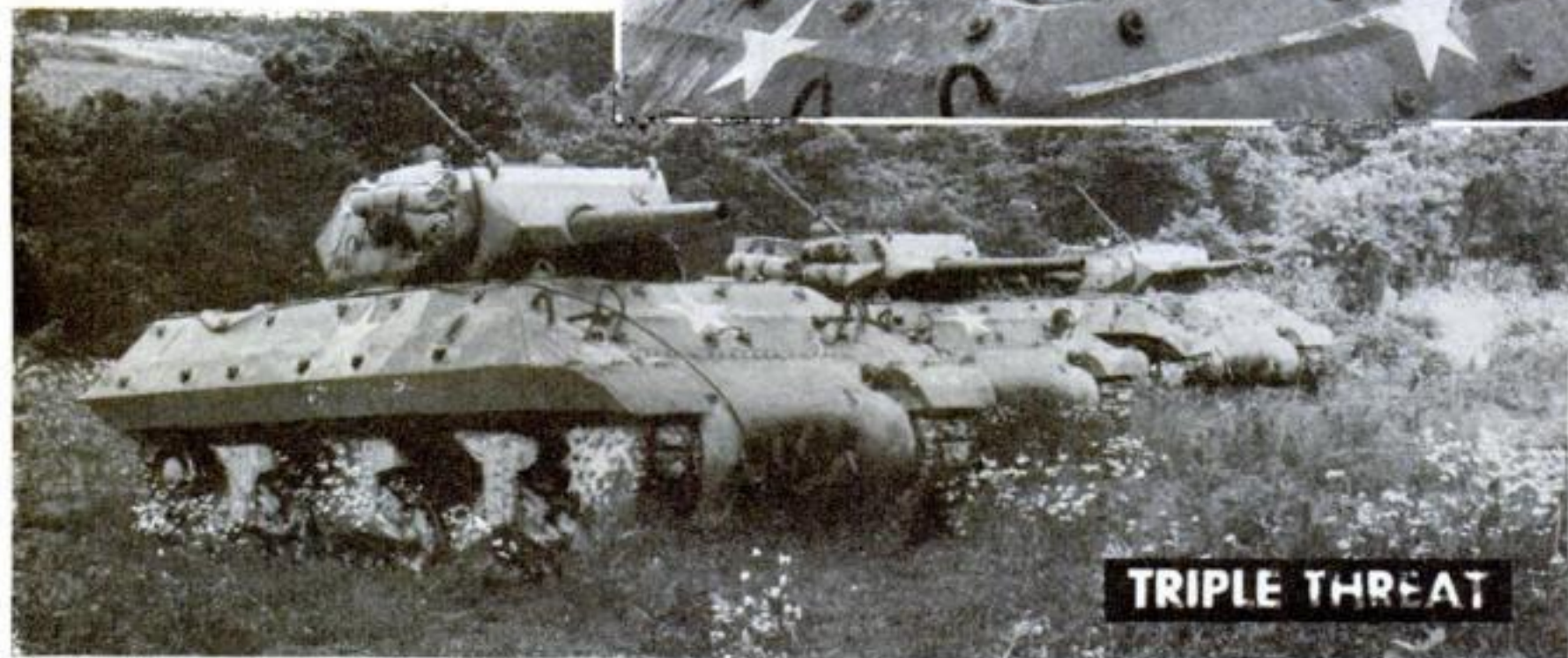


Poised atop the TD's turret, a .50 caliber antiaircraft machine gun is ready for enemy strafers and dive-bombers. This is the panther's main defensive weapon; crewmen are armed with tommy guns and grenades to use in case of attack by enemy personnel at close quarters

A trio of M-10's trains its three-inch high-velocity guns on a distant target. One solid hit with a shell from one of these guns will finish off an enemy tank at 2,000 yards



ANTIAIRCRAFT



TRIPLE THREAT

thinks his outfit's the best there is. That's typical of a tank destroyer commander.

When we met him, his TD was easily distinguished from the others in the battalion. On its turret was painted the snarling face of a black panther—symbol of the Force. Sergeant Horton stood by grinning a welcome.

Tank destroyers are relative newcomers in America's brood of war. The first command was formed in 1941, with Brig. Gen. Andrew D. Bruce, then a lieutenant colonel on the General Staff, as its chief. It went into operation as great Ford and General Motors plants began volume production of the antitank weapon. Resembling closely its mortal enemy, the M-10 consists of a high-velocity gun mounted on an M-4 (medium) tank chassis. Superior speed enables it to beat the foe to positions of ambush, and superior fire power enables it to make the kill. Though but one twentieth of an inch larger in bore than the famed 75-mm. gun, the three-inch gun fires a much heavier shell tipped with armor-piercing steel. A single solid hit will destroy a tank at 2,000 yards.

In an Army that now boasts many thousands of these deadly weapons, it's probably no great shakes to be the commander of one. But from a tactical standpoint every

destroyer commander is highly important. Each is a link in the chain of destruction closing slowly but surely around Axis armor. "Old Man" Horton knows this, as do the four members of his crew. They also know their job is rough, tough, and fraught with danger—and they love it.

Their training has the realism of war. Their rolling panther—33 tons of low-silhouetted steel and lead and gunpowder—is their textbook, and rugged, ravine-gashed countryside is their classroom. They learn the hardships, strain, and glory of actual combat. They learn to embrace the motto of their streamlined outfit: "Seek, strike, destroy!"

When we talked with Horton, he and his turtle-helmeted crew were nearing the finish of their training course. The destroyer commander said they were ready for the real thing and wanted it badly. Yet, only a few months earlier, they all had been novices in armored warfare. None had so much as an inkling of what was before him when he suddenly found himself assigned to the destroyer unit. They got their basic at destroyer schools, where each man became a specialist in his own right.

As prospective commander, Horton got the works. He learned to be artilleryman,

TRAVELING



On the prowl, the TD carries its big gun buttoned down over its tail. For firing, the gun swings up and the turret rotates, as shown at right. The destroyer is most effective when standing still in a concealed place

driver, mechanic, Ranger, map reader, camouflage expert, radio-telephone operator, reconnaissance expert, and father confessor. And don't discount the importance of the latter. For to maintain a happy tank-destroyer crew you must listen to and relieve all manner of minor woes. That may explain the "Old Man" tag on Horton.

Horton takes pride in his driver, Private First Class Morris Harper. "Red" Harper is as salty as any Georgian you ever met. His talk and movements belie his age. He was born 20 years ago in the little town of Swainsboro, and is the youngest member of the crew. He once drove small trucks, but today he's one of the best destroyer drivers around. Once he starts the big war machine rolling, he never changes the expression on his freckled face. We took a jaunt with him, riding alongside in the assistant driver's seat. Red took mud, muck, ditches, fords, and thickets in his stride. He looked straight ahead, found the gears automatically. Our glasses became flecked with mud. We ducked and grimaced. "Red" looked straight ahead and kept pounding along.

Steering a tank destroyer is the same as steering a tank. It

"FIRING"



WAITING



A halt under a sheltering tree is a welcome change from jolting across country. One man always stands guard with a tommy gun

requires skill, but it's simple. You have a lever in each hand. When you pull one, it stops the track on that side, speeds up the other track, veers you off. Working them back and forth, right and left, you cause the destroyer to weave from side to side. Shifting gears is more difficult, but any auto driver can learn it easily. You have five forward speeds. The big machine has no brakes, so you have to shift to a lower gear to slow down. It's done by double-clutching—going into neutral, engaging the clutch, bringing the engine speed into time with the lower gear, then completing the shift.

Horton rides in the bowels of the panther or atop the turret, when hitting the road. Beside him are his gunner and assistant gunner, Privates William F. "Pop" Jean, of Buechel, Ky., and Ernest Hill, of Sweetwater, Ala. At 36, Jean is the oldest in the unit. Hill is 22. Fifth member of the crew is Private First Class Wayne D. "Smitty" Ne-Smith, 21, of Eastman, Ga., assistant driver and radio operator.

When they get orders to stalk enemy tanks, they employ the skill and audacity of Indians, darting and slithering from cover to cover. The long three-inch gun is buttoned down on the tail, and if there's danger of enemy bullets the ports of the driver and assistant driver also are buttoned down. The driver and his aide see ahead through rectangular periscope windows, six by 1¾ inches. An intercommunication system makes possible constant contact with their commander, who now and again may rise above the open turret and take a spot-'em-first look for the enemy. The radio operator keeps in touch with battalion headquarters and other units in the mission, including mechanized reconnaissance forces that may have flanked the foe's lines.

It's up to the tank-destroyer commander to spot appropriate places of concealment. In a good hiding place, the panthers can "hull down" and lie in wait for approaching enemy armor. Sometimes they withhold their fire until unsuspecting tanks reach a point only 500 yards away, and then slam shells into the advancing tank column at the rate of 25 shots a minute.

Then, if enemy artillery gets after them, they can begin "getting the breeze"—scooting to a healthier position. In their tactical plans, the destroyers go in and out of hiding many times a day.

In the North African campaign, tank-destroyer commanders of the metal of Sergeant Horton won their share of fame. Foxy tank drivers of Herr Hitler's touted Afrika Korps learned to give them a wide berth. When enemy paratroopers attempted occasionally to round up a panther crew, they found themselves with a jungle cat by the

tail. For every man in a destroyer is armed with a tommy gun, in addition to hand grenades and a rifle grenade.

Talk consumes a great deal of the time when the crew is lying in concealment or in bivouac. It's a luxury, for you can't talk soldier talk while roaring and crashing across the countryside in that lusty battle machine. Also popular is "hittin' the sod"—stretching full length on the ground with or without bed roll. After jolting and banging in the destroyer, it's good to feel solid earth underneath you.

Once in a while you'll find the crew tidying up. That's when they have the luck to locate a stream or pool. Then it's wash day, and virtually everything comes in for a lathering. If there's time, even the destroyer gets a bath.

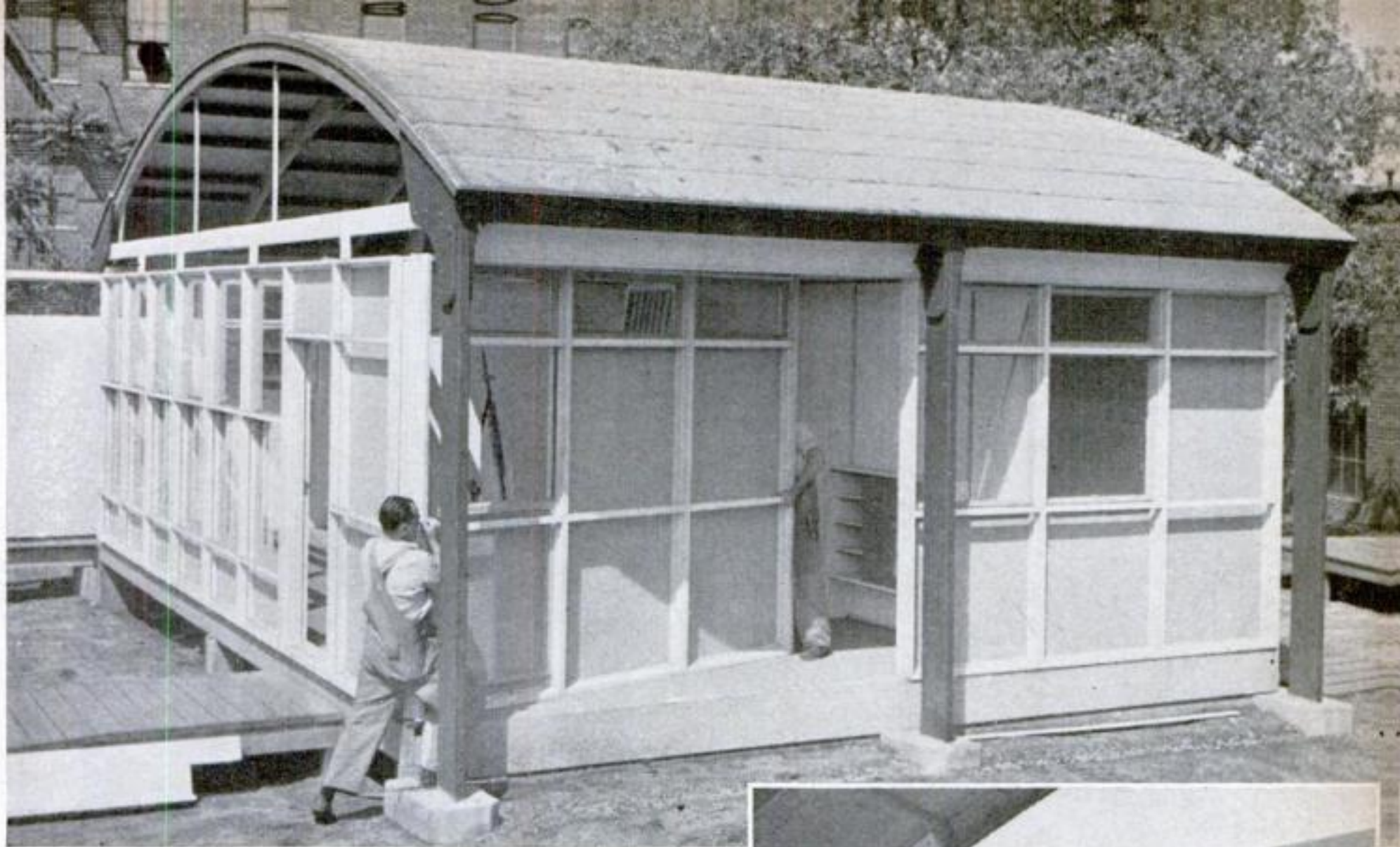
One man in the crew is kept on guard every minute the camouflaged monster is parked. He usually sits astride the turret, with his tommy gun slung handily across his knees. The men take turns at watch, in stretches of two to four hours. The guard knows the peril of surprise attack. His ears are trained to pick up sounds that might mean trouble. He's on the alert for enemy patrols and reconnaissance units, night prowlers laden with lead and TNT. Should they appear, he gives an alarm and an appropriate reception is arranged.

For daytime signaling, each destroyer carries three flags—green, yellow, and red. In the new fixed signals, different flags and combinations of flags mean: "Enemy approaches"; "Attention. Are you ready?" (when answered, "I am ready"); "Disregard my last order"; "Do as I do"; "Disperse"; "Increase space between vehicles, but maintain formation"; "Assemble"; "Gas attack," and other combat commands.

In addition to these signals, the destroyer commanders make signs to one another with their hands, employing the old system of motions used by Army drivers. Use of radio-telephones has cut down on the frequency with which hand and flag signals are needed. There are radios in each company of tanks, and 18 in the battalion.

Tank destroyers are the most important units in their battalion, but there's plenty of added wallop. For instance, each jeep lugs one of the now celebrated "bazookas"—the new antitank blasters. Then there are three-quarter-ton weapons carriers, half-tracks mounting .50 caliber machine guns, motor gun carriages with 37-mm. guns, and no less than 25 cargo trucks with ammunition and supplies.

But the rolling panthers are the beauties with the big sockeroo, and commanders like Sergt. Thurman Horton will see that the enemy finds it out.

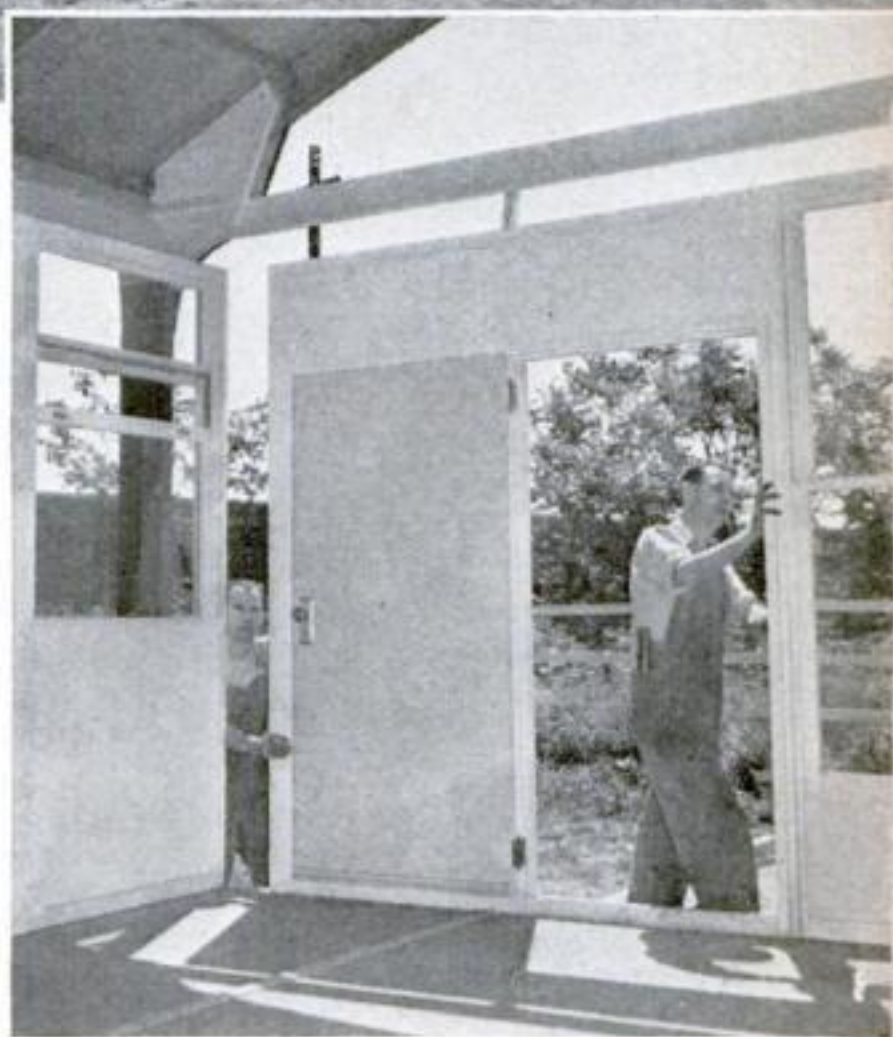
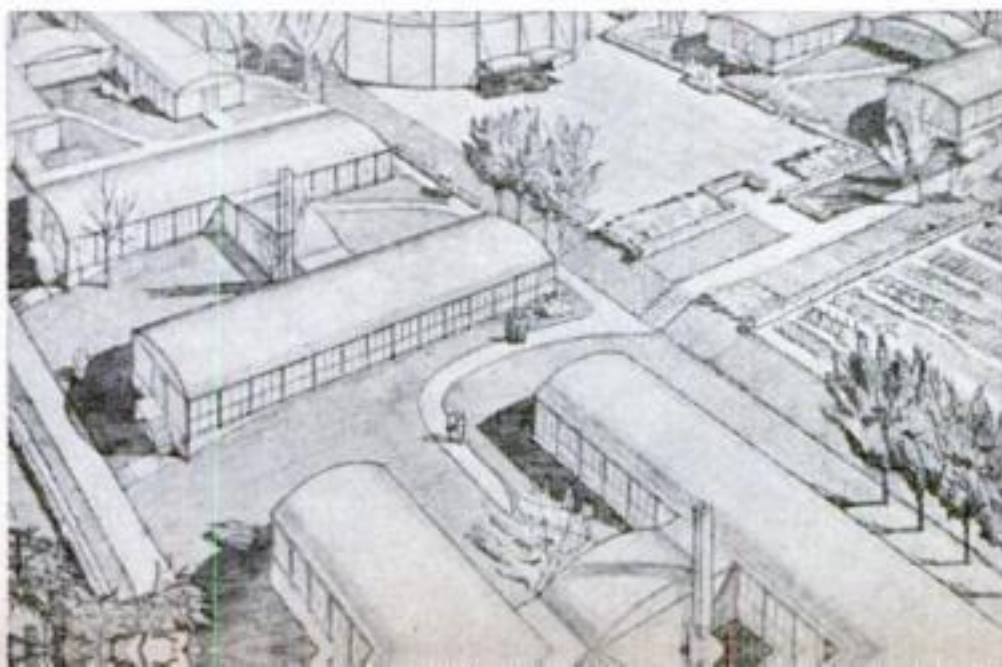


Outer walls, like this one being set into place, can be moved back and forward to provide porches in the summer and a larger living room in colder seasons

Houses for a Changing World

WARTIME houses like this one won't have to be scrapped when peace comes, for their size is easily changed and all their prefabricated sectional panels can be shifted to meet new requirements as they arise in a family or a community. Ratio Structures, as they are called, are the answer of architects Paul L. Wiener and Paul Schulz, and town planner José Luis Sert, all of New York, to the pressing and ever-changing housing demands of wartime. Weight is carried not by the outer walls but by a simple structure of wooden supports set on concrete blocks. Into this basic structure are fitted the outer walls as well as the inner dividing panels.

Here is an artist's conception of a Ratio Structures development of war workers' dormitories, readily convertible, in peacetime, into small homes or schools



All panels, like this façade section with its windows and doors all in one piece, are interchangeable, even after being installed

Ceiling sections fit as easily into place as wall panels do. The arched roof above is of wood and is constructed without trusses





THE WORLD'S LONGEST INDOOR RANGE, housed in an 1,800-foot tunnel, has been built by Remington Arms at Bridgeport, Conn., to test the fire accuracy of small-arms ammunition. Through bulletproof windows set in the ceiling of the tunnel (see left) observers also study the brilliance of tracer bullets. Blowers rid the range of gas and smoke, and a safety device locks the guns whenever the door to the tunnel is opened. A soundproof lining in the tunnel lets near-by war workers sleep undisturbed.



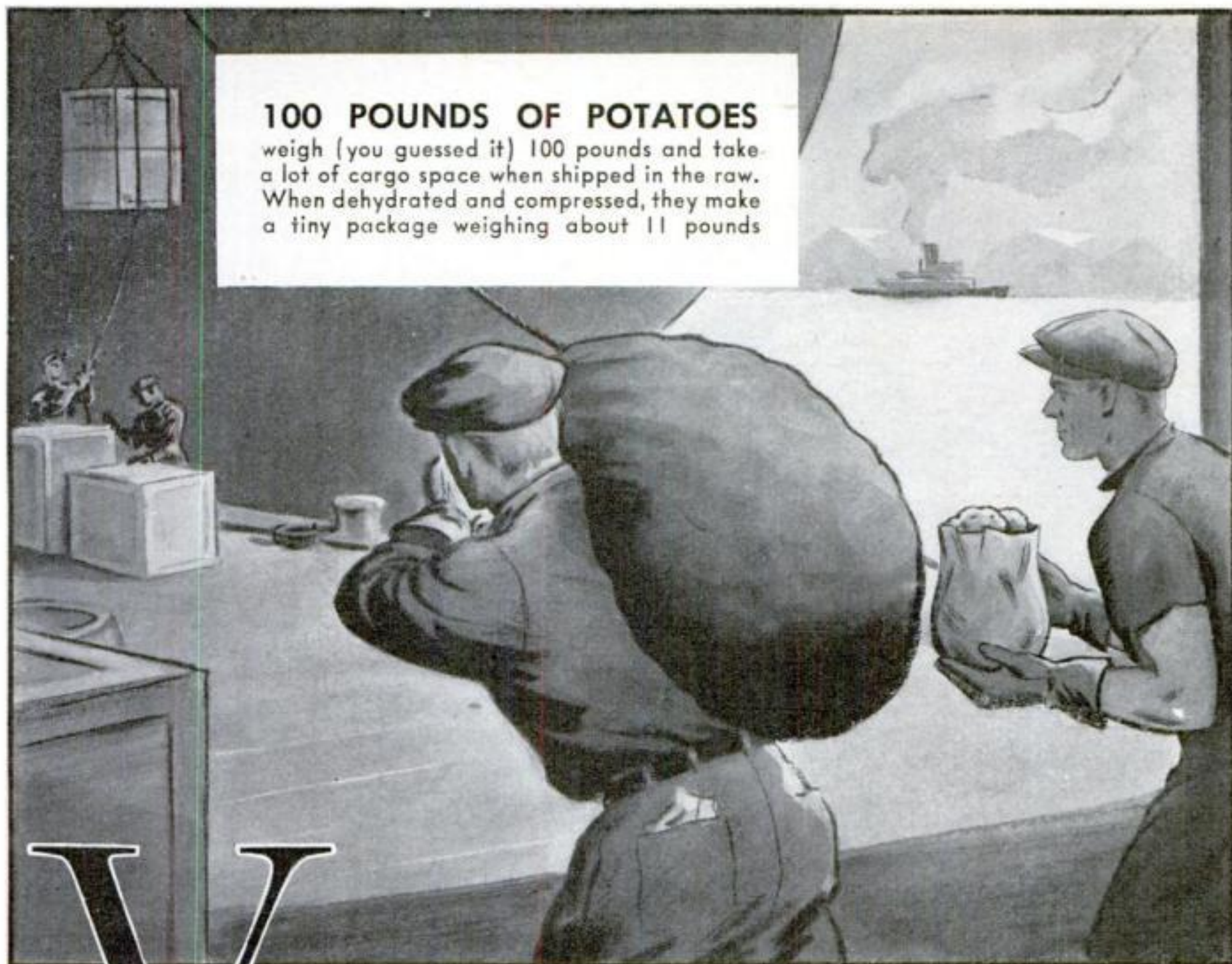
"FLAK JACKETS," representing a new style in bulletproof vests, are being issued to the members of our bomber crews as protection against enemy bullets and shell fragments, (P.S.M., Aug. '42, p. 104). Made of manganese steel and canvas, the jackets come in three parts: the front and back of the vest, and an apron. Pilots wear only the front piece and apron, as their backs are protected by armor plate. The rest of the crew wear all three pieces, which weigh a total of 16 pounds.



An officer inspects one of the new jackets that received its baptism in an air raid over Germany. At right, members of a bomber crew try on their steel-and-canvas jackets "for size"

100 POUNDS OF POTATOES

weigh (you guessed it) 100 pounds and take a lot of cargo space when shipped in the raw. When dehydrated and compressed, they make a tiny package weighing about 11 pounds



V-Foods vs. U-Boats

The story of an American inventor whose idea will help win the war—and may influence your eating habits for the rest of your life.

By ALLEN RAYMOND

ON DECEMBER 7, 1941, when the Japs attacked Pearl Harbor, John Cornelius Donnelly, 39 years old, of Greenwich, Conn., was stone broke; sitting in an unheated home, from which the gas, light, and telephone service had been cut off; wondering how to capitalize on great inventions to revolutionize the food-packaging business. He was suffering the usual difficulties of inventors.

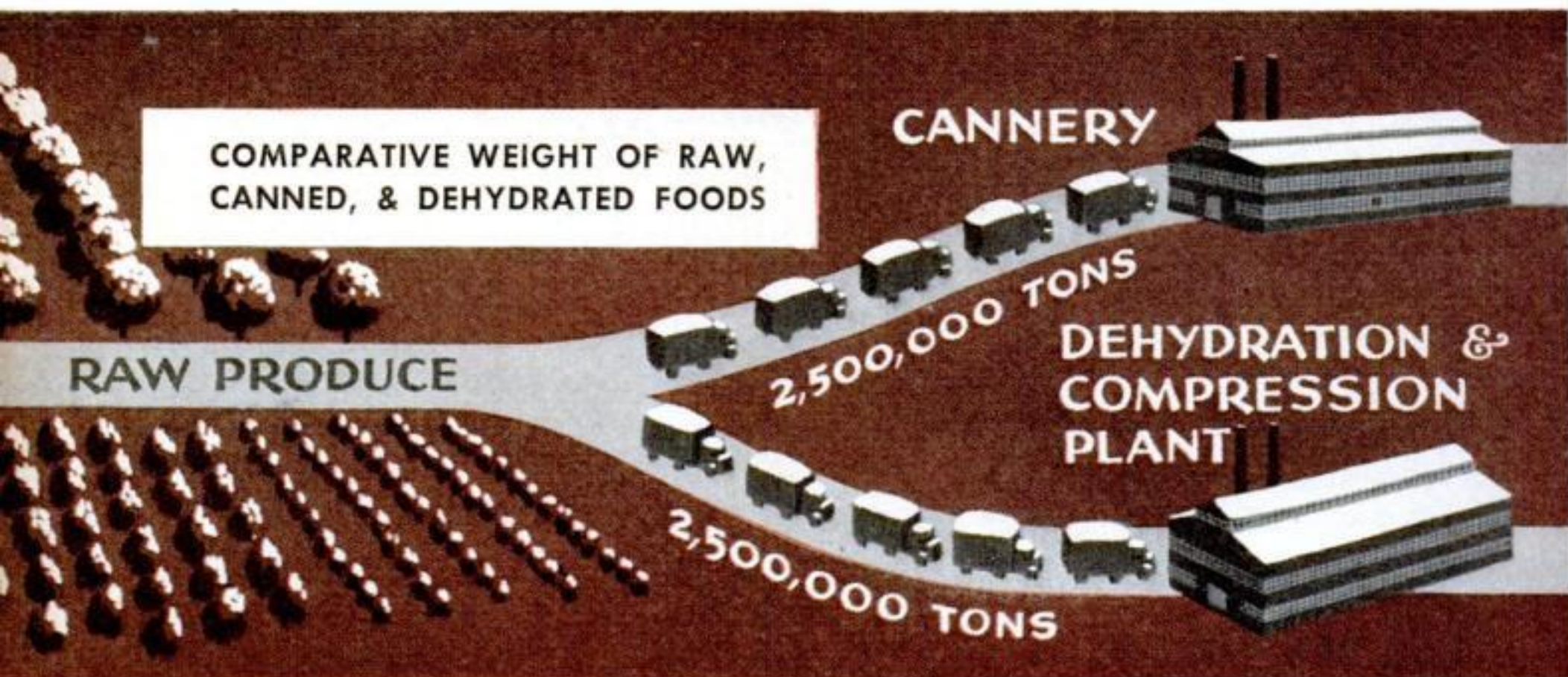
Within a year, Donnelly was the prosperous founder of a new industry hailed in Congress as a major contribution to the

American war effort. Nine agencies of the Federal Government, including the Army, Navy, Lend-Lease Administration, and Food Distribution Administration, by 1943, had delegated representatives to start laboratories working along the line of Donnelly's ideas, and to get factories into production on "V-Foods to fight U-Boats."

These V-foods are compressed, dehydrated vegetables, soups, meats, cereals, and other edibles, wrapped in specially treated paper or cellophane, and cubed into flat tablets, bars, or pellets for maximum saving of space and weight. Sometime in 1944, it is expected, vast quantities of these highly condensed food tablets will begin to travel around the world, by ship, train, and airplane, for American troops and for civil populations receiving American relief.

Their production will cut down the number of ships needed for food transport by large percentages. A chart produced by the Auto-Ordnance Company, of Greenwich, Conn., by which Donnelly is employed, maintains

COMPARATIVE WEIGHT OF RAW, CANNED, & DEHYDRATED FOODS



V-Foods

that ten ships will be able to carry all the dried fruits, fish, and mixed vegetables which now can be carried by 33 1/5 ships.

Enthusiastic prophets concerning the future of these food tablets say that after the war civilians may carry a full meal of three courses—soup, meat, vegetables, dessert, and coffee—around with them in a pocket or handbag, wrapped in a package the size of a cake of soap, for quick and easy preparation as desired, by the addition of a little hot water. They will be standard equipment for lifeboats and airplanes.

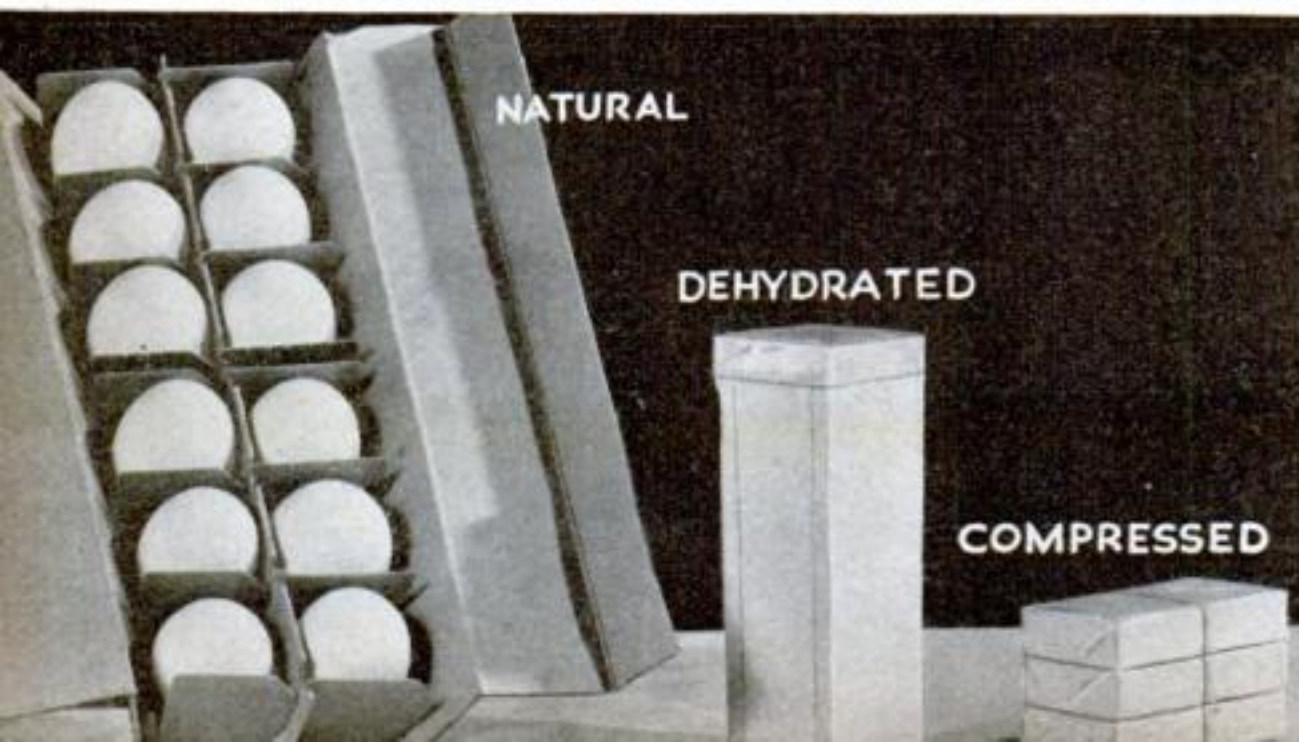
These capsules may cheapen the public's food bill by incalculable millions of dollars. They may cut the revenues of transportation companies by other millions, and by lower freight charges give wealth to the farmers. They are expected to cut heavily into the revenues of the tin-can makers, and generally to play hob with all prewar notions of food distribution.

In the meantime, laboratory makers of these tablets warn, a new industry will have to learn a lot about the art of making them

palatable, as well as nutritious. The public will have to learn a lot about their preparation, once purchased, and there will be a great many headaches for many people before these miniature foods become generally accepted and commonplace. The V-foods will be first tried out on the American Army in the field. The reaction of the troops is expected either to stimulate a great new industry, or set it back for some years, as food dehydration was set back for years by faulty products in World War I.

In this war, the production of dehydrated food is different. On March 17, 1943, E. R. Stettinius, Jr., Lend-Lease Administrator, gave a luncheon in Washington to 800 dignitaries of the United Nations. It was composed entirely of dehydrated foods, and was generally pronounced an excellent meal by persons sharing it. Fostered by the Federal Government, the production of dehydrated foods in the United States had risen from 100,000,000 pounds produced by 120 plants in 1942, to an estimated 400,000,000 pounds produced by nearly 800 plants in 1943. An even greater rise was predicted for 1944.

TO MAKE ONE OF OUR CARGO SHIPS DO THE WORK OF THREE



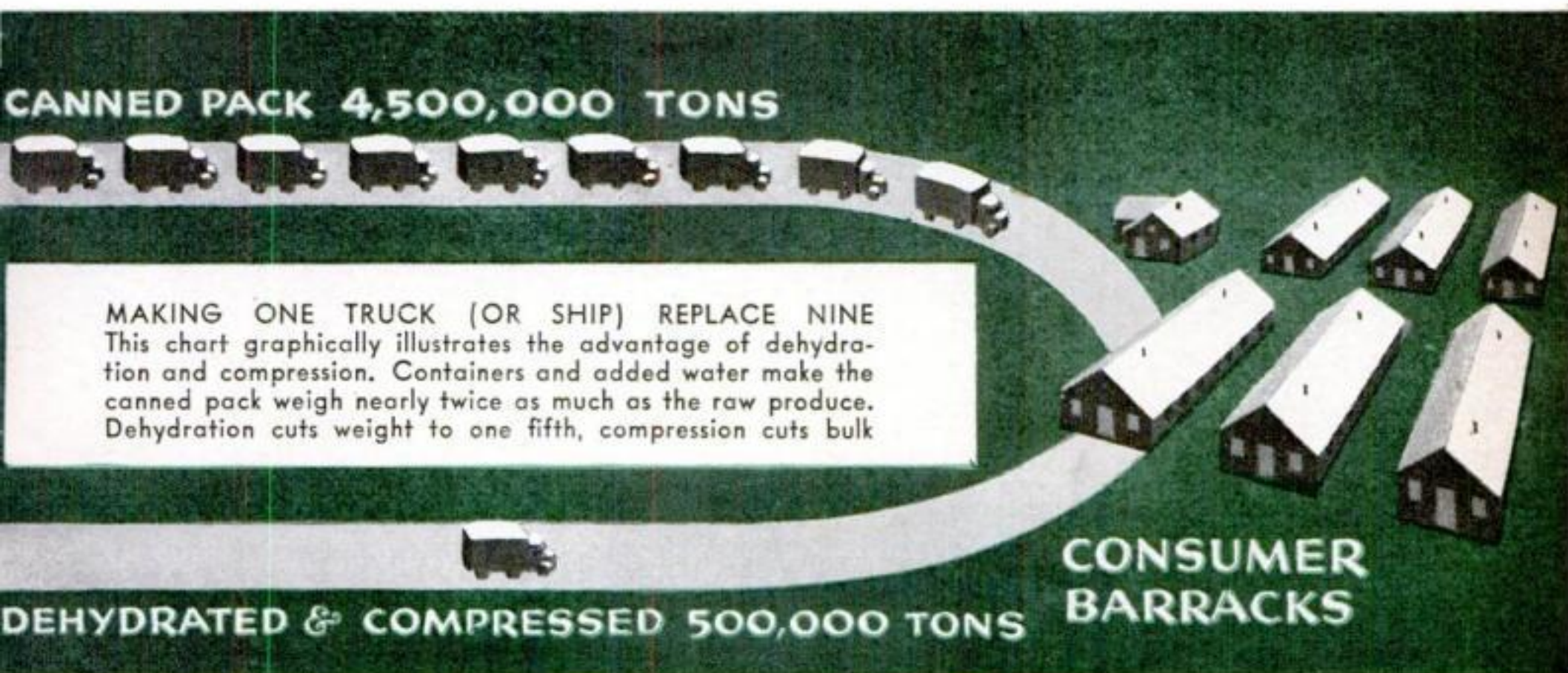
We'll be able to put all our eggs in a smaller basket with dehydration and compression. The dozen eggs at the far left comes down to the middle package when the water has been removed from them. Compression then further reduces the bulk to the six little tablets shown. On large shipments, as for Lend-Lease, savings in handling and shipping are tremendous.

CANNED PACK 4,500,000 TONS

MAKING ONE TRUCK (OR SHIP) REPLACE NINE
This chart graphically illustrates the advantage of dehydration and compression. Containers and added water make the canned pack weigh nearly twice as much as the raw produce. Dehydration cuts weight to one fifth, compression cuts bulk

DEHYDRATED & COMPRESSED 500,000 TONS

CONSUMER BARRACKS



Dehydration consists merely in removing the water from foods. Most foods contain from 10 to 90 percent water in their natural state. Debulking them by this amount has saved many thousands of tons of shipping and storage space, in the sending of food to this nation's troops and allies overseas. Even with this saving, it was estimated in January 1943 that 40 percent of Ally-destined cargoes consisted of foods.

If this percentage could be decreased, more munitions could be shipped, or more men. The primary purpose, then, of the Government in fostering the Donnelly idea was space saving.

The Army Quartermaster Corps went to work on this problem. The food technology laboratories of the Massachusetts Institute of Technology, the Western Regional Research Laboratory, Albany, Calif., and the Department of Agriculture co-operated.

Industrial compression specialists from the Baldwin Locomotive Works, Eddystone, Pa., and the Pneumatic Scale Co., Quincy, Mass., were called in. Beginning in the autumn of 1942, a survey was made of presses

available for the compression of foods in industries of curtailed activity due to the war emergency. Some presses were found adaptable to food compression and others not. Some could be used on some foods and not on others. New-type presses were designed, and production on one new type was begun at the Baldwin Locomotive Works.

So also, under the direction of the Army Quartermaster Corps, a survey was made of foods capable of compression. These were roughly grouped under two classifications:

1. Powdered products, such as milk, eggs, soups, vegetables, fruit powders, seasonings, cereals, flours.

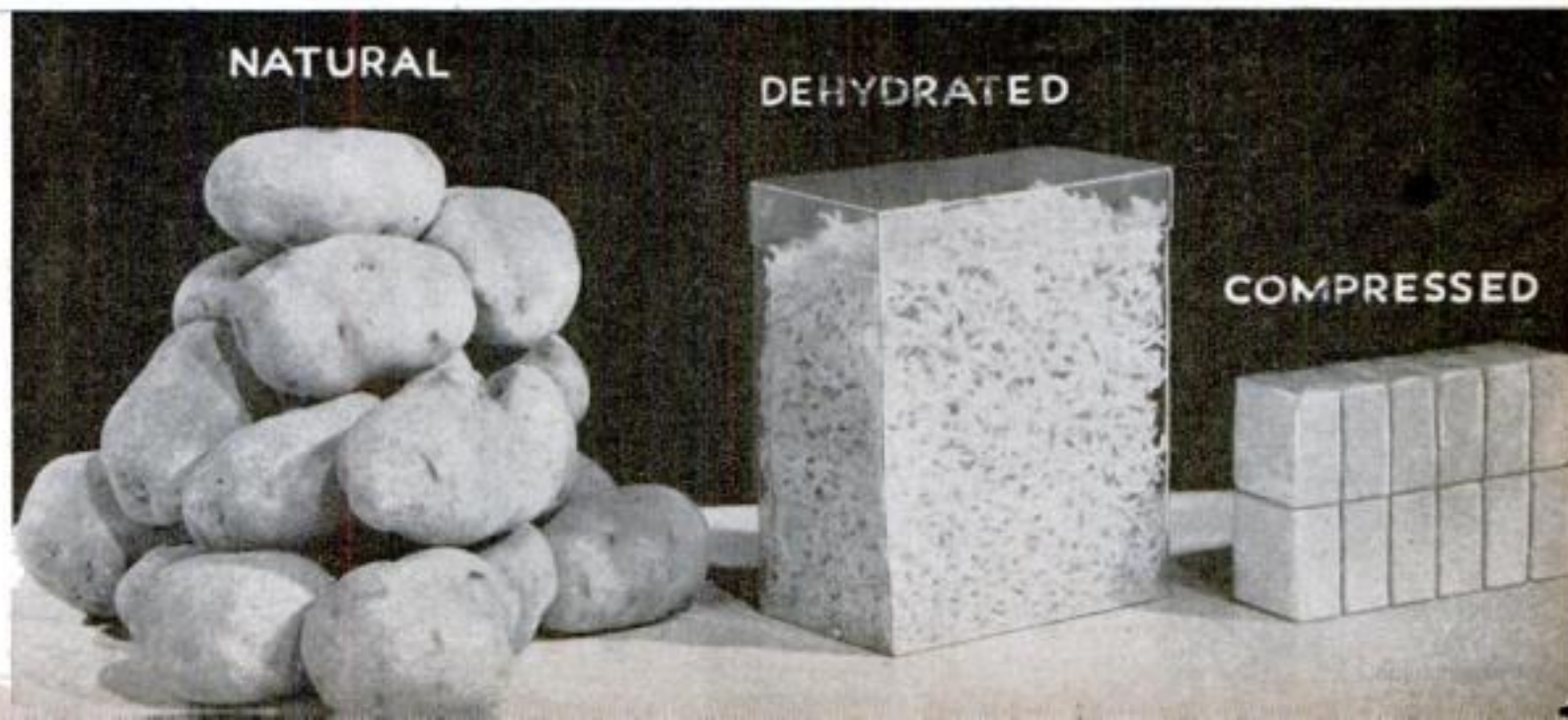
2. Piece products, such as vegetables, fruits, dry legumes, whole grain or bean products, meats, and animal feeds.

By March 27, 1943, the Army had evolved a preliminary program for the compression of fruits, onions, soups, cranberries, and egg powder by which it was hoped to save many thousands of ship tons in transport space, but every project was either in the laboratory or experimental small-order stage.

The first factory in the United States de-

DEHYDRATION REMOVES WATER, COMPRESSION REMOVES AIR

Potatoes lose a total of more than 90 percent in volume and 88 percent in weight by dehydration and compression. In addition to reducing bulk, compression increases resistance to moisture, oxidation, infestation



signed specially for food compression was to be opened in Lyons, N. Y., July 1, 1943, by the Auto-Ordnance Co., using the Donnelly processes, some of them patented and others held as closely guarded trade secrets. This factory was to compress seven types of powdered soups for the Dry-Pak Corporation, all destined for lend-lease shipment. The soups were spinach, tomato, potato, peppercorn, borscht, pea, and navy bean. All were to have a soy-bean ingredient to increase the protein content.

According to Donnelly, there are three major factors in the compression of dehydrated foods. They are temperature, amount of compression, and time. Some foods press better when heated, others when frozen. Each food is an individual problem. Pressures may vary from a few hundred pounds per square inch up to several tons. The time of the pressure may be either a slow squeeze or a sharp rap.

"Pressing food isn't like baling hay," says the inventor. "There's more to making shoes than tanning leather. It isn't enough to put your emphasis on reduction of bulk, even in wartime. You have to consider the reconstitution of the product: whether it will be appetizing and easily digestible. People who go into this industry are going to have their troubles, until they learn by long laboratory research just how to treat each food. We have been experimenting with a baby food for the last seven months. I doubt if we will be content with our product, even though it seems all right now, for another year."

Donnelly started his experiments in food compression in 1936. He came to them with the viewpoint of a man who had been experimenting in packaging. He had worked some time in the laboratories of the Du Pont corporation, testing the packaging of various food products in seamless cellophane containers, or paper containers with cellophane liners.

He found that every food he tried to package presented a different problem. In peanut butter, the problem was the retention of oil. In powdered milk, it was resistance to moisture. Packaging sirups brought him the problem of fermentation. Then he tried to package freshly roasted ground coffee. The first package he packed, he says, exploded. The coffee was giving off a gas.

He spent two years studying how to overcome this. Most of his spare time was spent in the New York Public Library, examining the files of chemical abstracts. He finally concluded, he says, that if fresh-roasted coffee were refrigerated in carbon dioxide, and compressed into a solid, it could be packaged.

V-Foods

From 1935 until 1937, he bought pound after pound of coffee, experimenting with it in his home. He had a small hand press, manufactured by Fred Carver, of New York. He found that a pound of his compressed coffee would yield about 50 cups of the beverage—as against 35 or 40 cups of the same strength from a pound of an ordinary coffee sold loosely or canned.

When he believed he had it perfected, he took it to a large New York advertising agency. He was told, he says, that it was not marketable, since the small package would have no sales appeal to women. Then, from his home in Hartsdale, N. Y., he took some samples to a frozen-foods store in near-by White Plains.

He made a deal with the proprietor to place 10 pounds daily in his refrigerator.



An armful becomes a handful: Dehydrated potato shreds in the larger package shrink under pressure to small bulk—which still serves 100 men liberally

It was advertised by a placard, nine by 18 inches, on a counter, upon which Donnelly printed: "Fresh, frozen coffee, 35c a pound." The first day he sold one pound; the second, five pounds; and thereafter ten pounds daily, for several weeks. That was all he could make.

His customers were practically all repeaters, and he began to gather their testimonials. "One woman told me she got 80 cups to the pound," he says. "She liked it weak."

A friend of Mrs. Donnelly, the inventor says, first interested him in the compression of dehydrated vegetables. He received some samples, and began to experiment. By this time he was so obsessed with the idea of food compression that he gave up all other work, except for odd jobs which he could

do at night, so that he could spend his days in his laboratory at home, or in the New York Public Library.

Compressing samples of dehydrated foods, he and Mrs. Donnelly ate the result of the laboratory tests. Sometimes, he says, when he felt he was fairly successful, his wife objected that the stuff was terrible. Therefore, he kept trying to improve it. He wrote to officers of numerous food industries, telling them of his experiments, and asking them for samples. The samples arrived, and the Donnellys kept eating.

Early in January 1942, he heard through a friend that the Auto-Ordnance Company, 1 Wall Street, New York, makers of those famous submachine guns known as "tommy guns," had established a research and development division to seek new products for the postwar era. From January 6 to April 3, 1942, he says, he dogged officials of the



Donnelly compares cranberries in their natural state with the dehydrated, compressed, cellophane-wrapped form in which they may soon be marketed

company until he signed a contract with them to set up a laboratory for the purpose of developing his own process of food compression.

During this period, the inventor frequently took a dime in the morning and hitch-hiked his way from Hartsdale, N. Y., to the Manhattan subway. Five cents carried him downtown in the morning and five cents took him back to another hitch-hiking adventure in the evening. Ten hours a day were frequently spent in the round-trip travel which commuters by train and subway accomplish in less than two hours.

The father of compressed foods has to laugh today at these adventures. With the signing of his contract, the Auto-Ordnance Company took over a fairly pretentious sales building of the Ford and Lincoln agency in

Greenwich, Conn., in which to install their food-compression laboratory.

In charge of this laboratory, Donnelly became the chief of a staff of 10, including a chemist, physicist, bacteriologist, mechanical engineer, and six laboratory assistants. His financial troubles were ended. The Auto-Ordnance Company and officials of the Du Pont corporation, promoting the use of cellophane as a substitute packaging material for tin, interested Federal officials in fostering the new compression industry.

Figures from the Massachusetts Institute of Technology on the percentages of volume reduction possible for eleven food products, under pressures ranging from 400 to 2,000 pounds per square inch, at temperatures from 70 to 140 degrees Fahrenheit follow:

Carrot shreds, 65%; beet shreds, 65%; rutabaga shreds, 64%; cabbage flakes, 82%; onion chips, 65%; sliced sweet potatoes, 60%; whole cranberries, 84%; apple nuggets, 73%; bean soup, 50%; whole eggs, spray dried, 42%; beef, or hamburger steak, 70%.

Financial savings possible by compression of dehydrated foods have been calculated by the Cambridge Tile Manufacturing Co., of Cincinnati, Ohio, which received early in 1943 an experimental order for 3,000 pounds of egg powder from the Lend-Lease Administration. Upon 100,000,000 pounds, or only a fraction of what may be sent abroad before the war and postwar relief are ended, the company estimated, total savings to American taxpayers would be as follows:

Containers, \$348,400; storage, \$39,300; manpower in handling, \$13,300; inland freight charges (Cincinnati, Ohio, to British cities), \$42,500; ocean freight charges, \$2,310,000; total, \$2,753,500.

Dehydrated foods already bought or sought under programs of all Federal agencies in February, 1943, totaled more than 1,500,000,000 pounds, according to publications of the western canning and packing industry. Not any yet acquired had been compressed.

Proponents of compressing dehydrated foods maintain that if properly prepared these tablets have numerous advantages over foods more loosely packed, or canned. Compression, they say, reduces bulk, perishability, metal and other packaging requirements, need for gas or vacuum packing; truck, rail, and ship cargo-space requirements, storage-space requirements, distribution manpower requirements, and packaging, material, and handling costs.

Compression, they assert, increases the foods' resistance to oxidation and moisture. It increases their resistance to infestation. It adds to convenience and speed of handling in packaging lines, and preservation of the product during shipment.



NO POINTS REQUIRED

DON'T push, folks. There's plenty to go around. And, though prices may seem high, with a veal cutlet at \$2.25, this is no black market. For these foods are artificial. They are of a plastic material, realistic in texture, molded to natural shape, and colored to challenge the appetite. The Imitation Food Co., of Brooklyn, N.Y., offers a menu of hundreds of items. Designed for display in restaurants and food shops, their products serve also as educational aids and as properties in plays and movies.



Dieticians now learn their rules the easy way. In New York City hospitals, foods and quantities of a 100-gram diabetic diet are demonstrated with a special 45-piece set of artificial foods



The composition used hardens swiftly. Just 20 minutes from liquid plastic to molded turkey, ready for browning

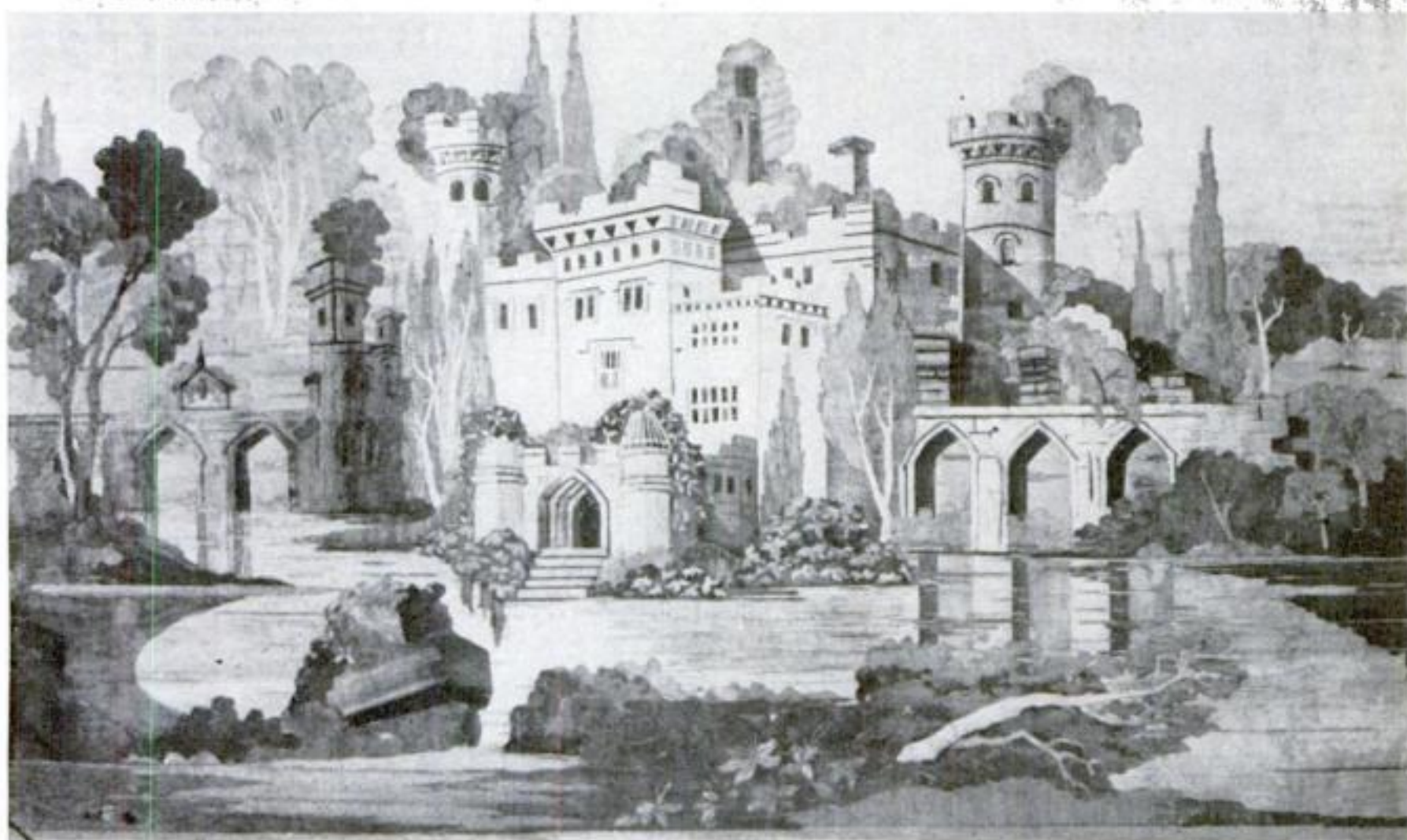
Photographs by SAM SHERE

A special mixture, as in all items, makes the turkey's texture realistic; and browning takes expert coloring

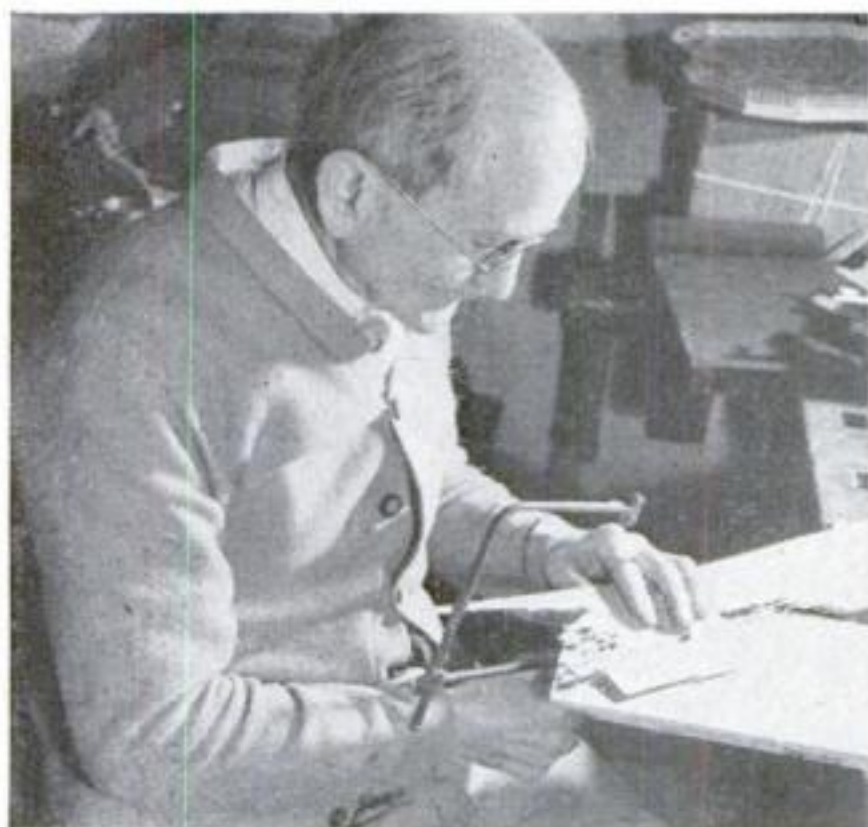


Fresh fruits and vegetables, too. Everything from canapés to apple pie with cheese, and not a nibble in a carload. No spoilage, either. All it takes to keep it fresh is a daily dusting





Artist Paints with Colored Wood



"PAINTINGS" made up of thousands of tiny pieces of wood of varied natural colors are the specialty of John Wacha, 69-year-old retired jewelry designer, of Providence, R. I. After sketching his design on a baseboard "canvas," the artist sorts out the various shades of wood he needs, and with a fine jig saw he cuts the selected pieces into intricate patterns, many of them only a fraction of an inch wide. Using delicate jeweler's tweezers, he painstakingly fits the tiny "paints" into place. Small flowers, less than half an inch wide, may contain as many as 20 pieces, and a good-sized picture will take about four months to produce. The finished "canvas" shown above is 17 by 23 inches, and contains about 4,000 pieces of various woods ranging in color all the way from black to white.

WOODEN REGISTERS are the first business machines to be built since the WPB banned the manufacture of their metal fore-runners to conserve critical materials. The autographic register is made by the Standard Register Co., of Dayton, Ohio, which experimented with glass and plastics before deciding on laminated wood for the case and hard wood for the working parts. Incapable of sparking if struck, the registers are especially suitable in ordnance plants.





Plastic Light Filters "Black Out" Pilot for Blind-Flying Training

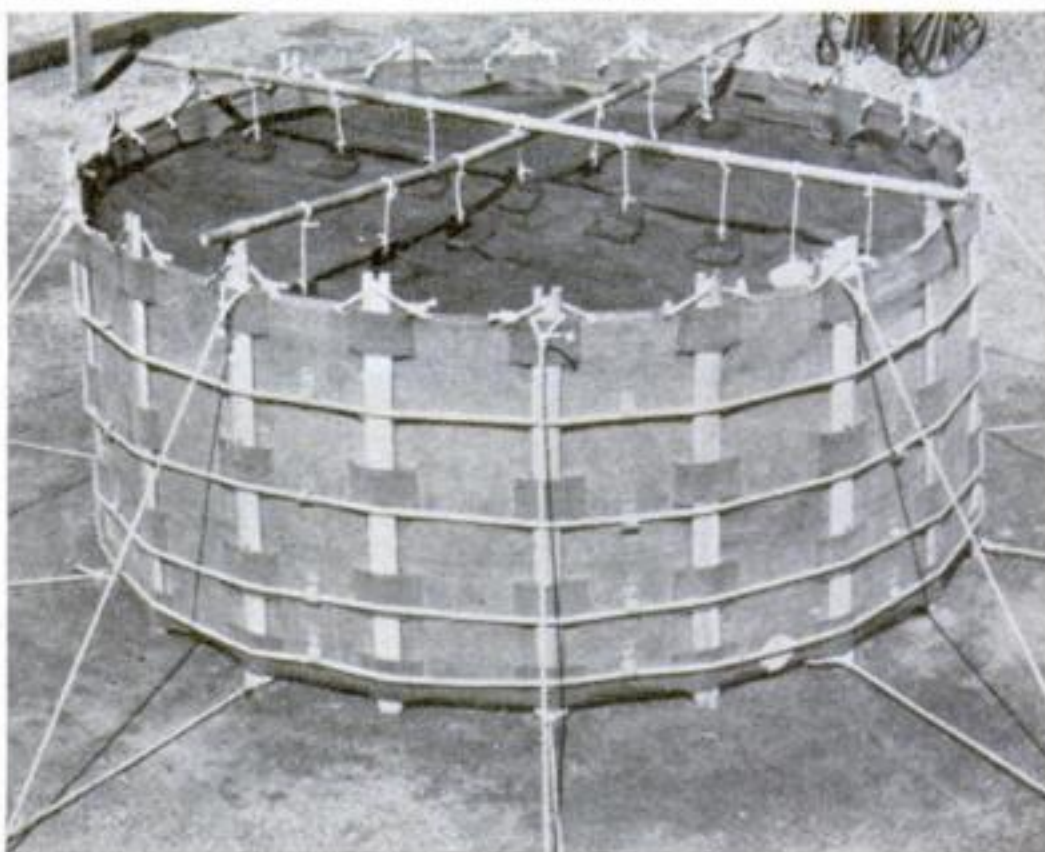
A ONE-MAN blackout system, developed by the Polaroid Corporation, of Cambridge, Mass., for blind-flying instruction, uses a sheet of transparent green plastic mounted against the plane's windshield, and a pair of red plastic goggles worn by the student, also transparent, but admitting no light filtered through the green shield. This cuts off any view outside the plane. Both student and instructor can see the instruments, but the latter, who wears no glasses, can get a free out-



side view that enables him to check on landscape obstructions and plane traffic. In the traditional method of teaching, an opaque screen is erected around the student so he can't see the ground, but this also limits the instructor's view.

AN ADAPTATION of the Mar-eng cells first used as auxiliary gasoline tanks for planes, these foldable 500 to 10,000 gallon storage tanks with thiokol bladders are being used by the Army for quick erection in battle areas. The cell bellies like a balloon inside its canvas jacket when filled with fuel, which it forces out under pressure without the use of a pump. Collapsed jacket is shown below.

Collapsible Gasoline Storage Tank of Synthetic Rubber Helps to Solve Army's Supply Problem in the Field





On the right sits the flying instructor with an unimpaired vision of everything inside the plane, and with a green-tinted view of the landscape. The student, who is learning to fly by instruments alone, can see them easily through his red goggles. But he can't see outside the plane because the green plastic against the windshield cuts out the light in all but the blue-green part of the spectrum, and this the red goggles cannot transmit.



Bombardiers' "Highchair" Helps Sharpen Their Aim

WITH his secret bombsight mounted on this wheeled platform, a student bombardier is guided over a scaled target to practice accuracy under simulated flight conditions in the AAF Bombardier School at Midland Field, Texas. "Highchair" travels at a speed corresponding to 120 m.p.h.

Mounted on a platform called a "bug," the paper target is towed into various positions while the bombardier tries to hit it as he moves through changes in flying positions

CAPTURED PIECES REVEAL STRENGTH

Our Enemy's

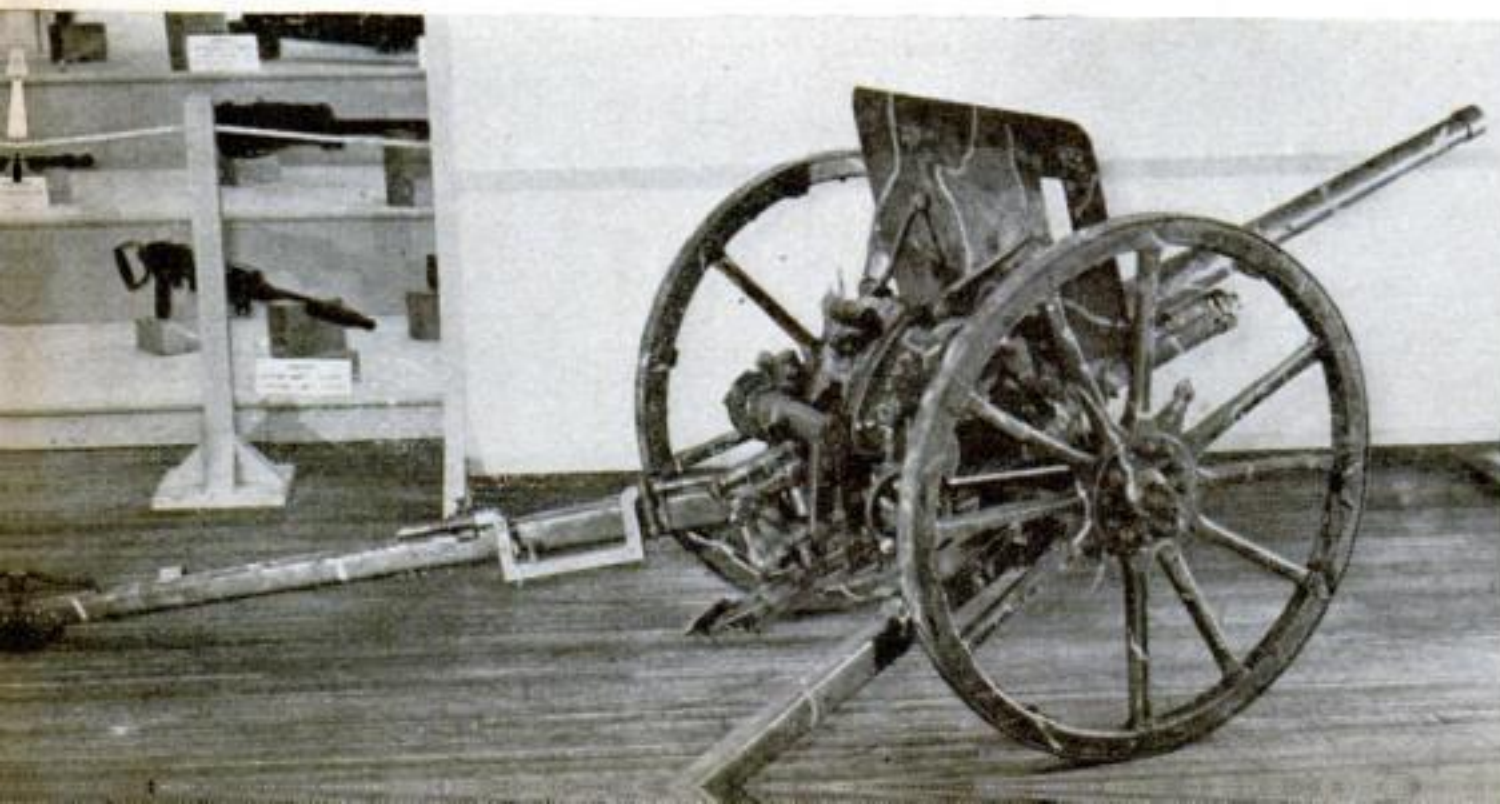
VITAL to good battle strategy is a knowledge of what kind of weapons the enemy has, and just what these weapons can—and cannot—do. To gain this information, members of the Army's Foreign Materiel Division, following in the wake of a retreating enemy force, pick up any new weapons they may find, and ship them home for careful analysis. Besides learning what types of guns our troops are facing, the Division's engineers sometimes find innovations that can be incorporated in our own weapons, or make the important discovery that certain ordnance parts are being made of *ersatz* materials — indicating that the enemy is also having to retreat on the production front.



GERMANY'S 50-MM. MORTAR, with base, weighs 31 pounds, is muzzle-loaded and trigger-fired, has an elevation range of 43.5-90 degrees, total transverse range of 30 degrees, firing range of 50-550 yards. Projectile is two-pound high explosive with fin assembly



NAZIS' 81-MM. MORTAR weighs 125 pounds, can throw a 7 $\frac{3}{4}$ -pound high-explosive bomb 2,078 yards. Muzzle-loaded projectile is fired when cartridge, in fin assembly, comes in contact with firing pin in the barrel

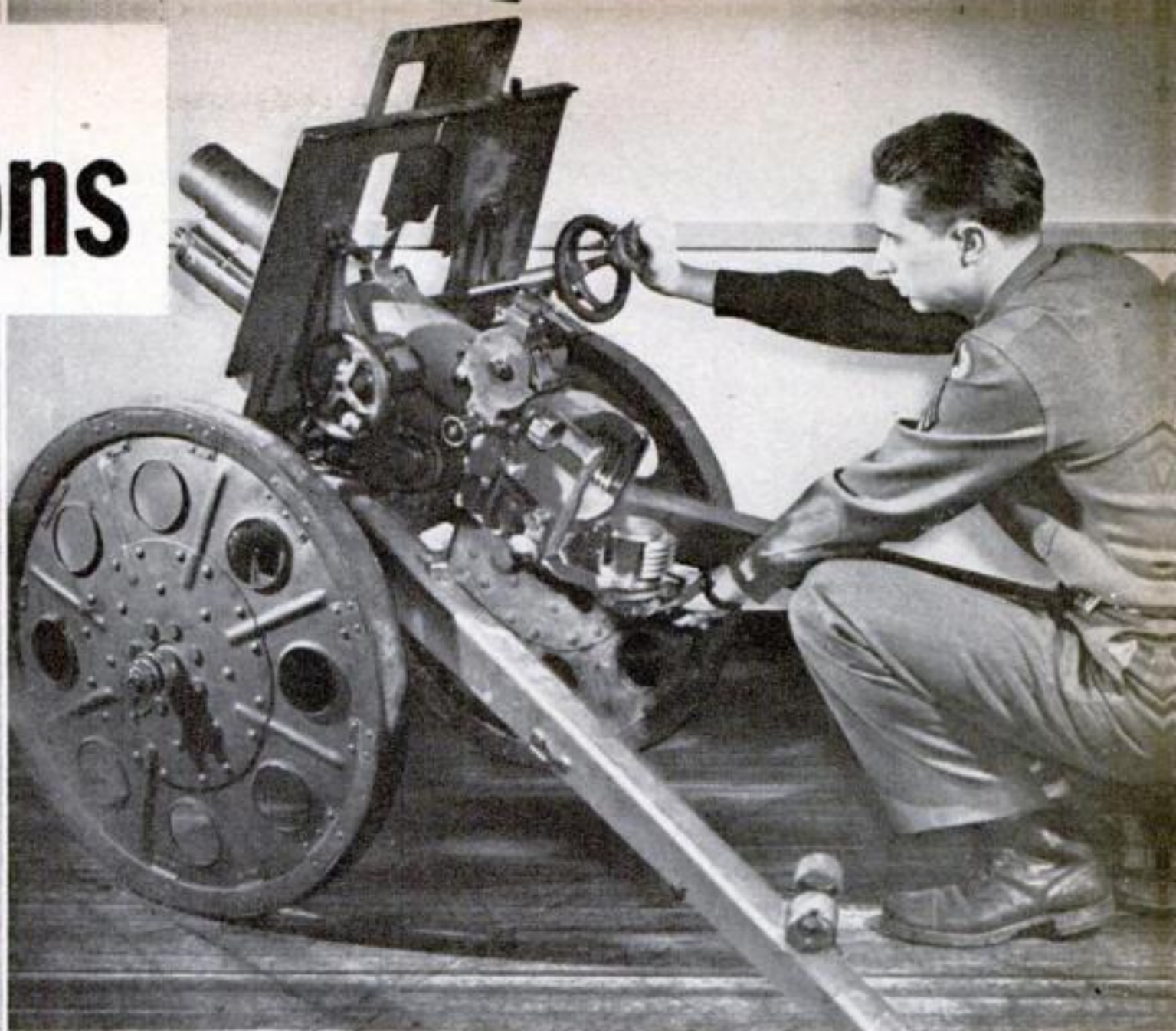


JAP ANTITANK GUN is a 37-mm. rapid-fire, high-velocity piece with maximum effective range of 2,500 yards. Operates with two-man crew, and has full automatic rotating breech-lock. Danger area of shell burst is very limited. Gun is poorly constructed and, like howitzer (top right), indicates an inferiority in our enemy's armament

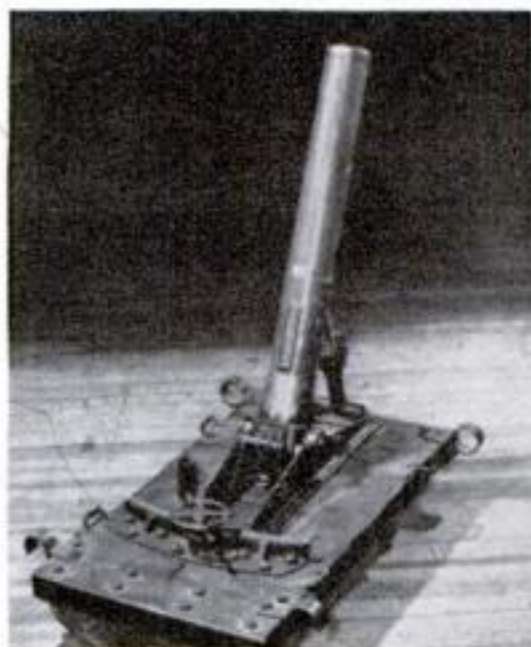
AND WEAKNESS OF

Weapons

JAP HOWITZER is 70-mm. rifle with effective range of 300-1,500 yards and fire rate of 10 rounds per minute. Danger area of bursting shell is only 40 yards. Dating back to 1922, this model indicates Japs are short of modern weapons, are being forced to employ long-outmoded equipment



ITALY'S 45-MM. MORTAR is breech-loaded, trigger-fired weapon that can throw 25 to 30 one-pound bombs per minute, weighs only 34 pounds, has both low and high-angle range. Bomb fragmentation, however, is poor

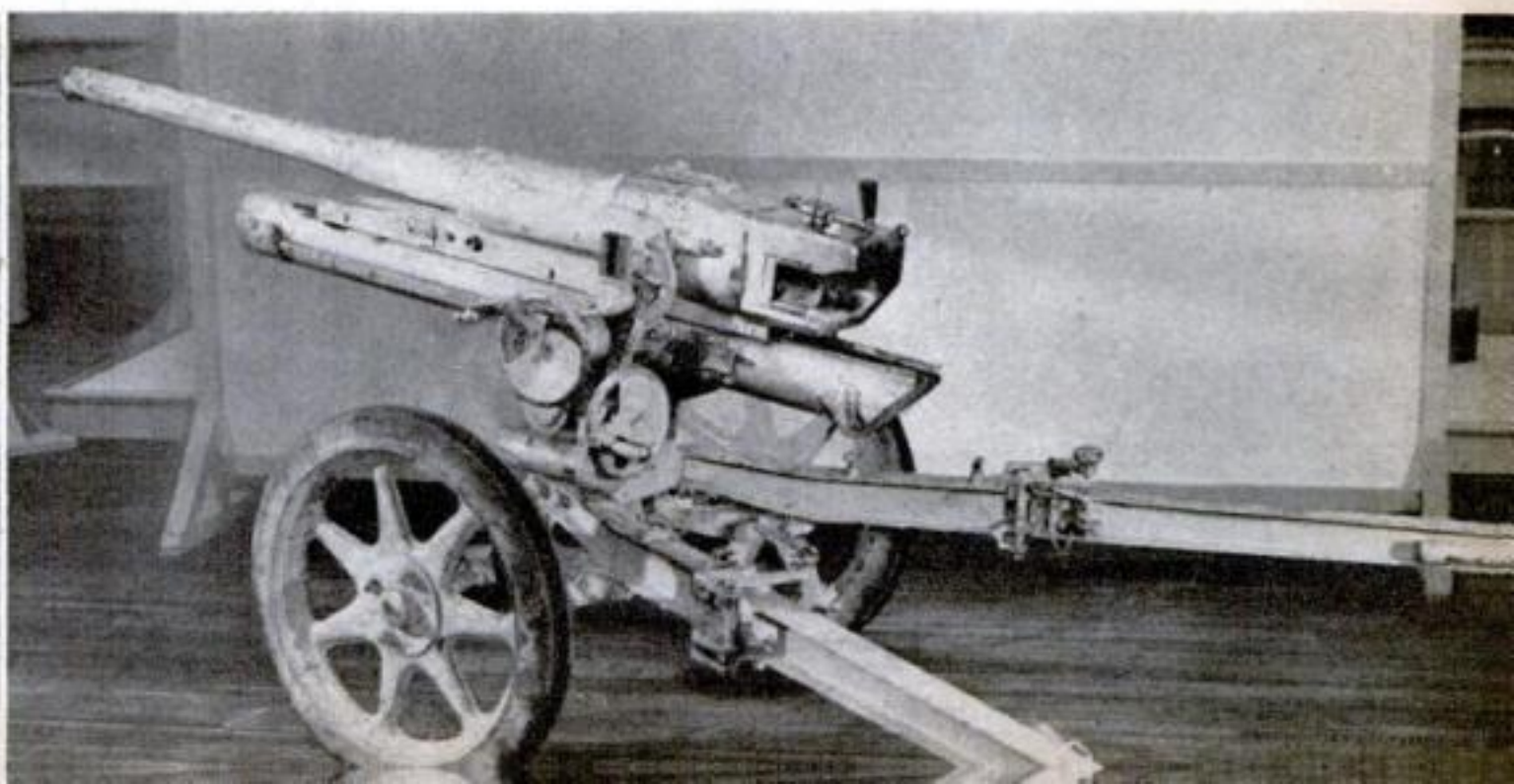


JAPAN'S 70-MM. MORTAR is patterned after Germany's 81-mm. weapon. Pieces projecting from plate appear to be pole holders for hand portage



JAPAN'S LIGHT MORTAR is 50-mm. piece with 700-yard maximum range. Right, smoke grenade and demolition bomb appear over four-place sack

ITALIAN ANTITANK GUN is Breda 47-mm. weapon, capable of firing 20 rounds of armor-piercing shells per minute. A 1932 model, it is used primarily as an infantry weapon. Like all Italian pieces captured in the African desert, the gun is painted a dingy mustard color for purposes of camouflage. It is considered extremely mobile



"Ghost Plane" Fights On

By all the rules, the 10-year-old Catalina should be as dead as the dodo. But she still hangs on . . . and now her big sister Coronado helps carry on the battle.

By ANDREW R. BOONE

THE normal life expectancy of an airplane design is about four years. Under normal military operation, a fighting plane is superseded by types that can outperform it, as design science strides past yesterday's milestones. New engines, better propellers, improved wing sections, and superior materials make yesterday's winged miracle tomorrow's crate. Even in commercial air-transport design, a four-year-old airplane type is about ready for the freight runs in the backwoods.

There is one holdout in airplane design: a Navy-type flying boat that has managed to survive a full decade and is now ready to be reordered—the Consolidated PBV-5, the tough, indestructible Catalina. The latest dope on the "Cat" comes in an unobtrusive release from the financial department of Brewster Aeronautical Corp. Some weeks ago, this company's Newark division, which had been engaged in building wings and tip floats for the Cat, completed what was believed to be the last order for Navy PBV boats. A new, slick twin-engined ship with a deep hull and a swift, high-

aspect-ratio wing was going to take its place. The old Cat was, at last, going to die.

The idea evoked sighs of mingled nostalgia and relief in certain Navy flying circles. The Cat was a slow, ungainly flying boat with apparently little to recommend it in a modern war. Before the Sudenten occupation, the Navy had released it for commercial purchase, and even allowed Consolidated to sell license rights to Soviet Russia. Now, for all practical purposes, the Cat was to be allowed to die. Then, with dramatic suddenness, Brewster announced that a new contract for Catalina wings and tip floats had been signed. The Cat had a new lease on life.

The Catalina's record in this war is a glorious one. It began with another reprieve, this one by the British. The R.A.F.'s Coastal Patrol needed a good production-type flying boat, and needed it quickly. Consolidated Aircraft had a splendid flying boat in the prototype stage, with primary tooling already under way. The British, however, needed immediate deliveries on seaplanes—needed them desperately, to patrol the seaways around the embattled island. They decided to forego the airplane of tomorrow for one they could fly immediately, so the Cat, which was scheduled for the limbo of Jennies and Liberty DH's, was put back into production as a stopgap. She has been filling the gap ever since.

Despite her lack of speed, the Cat is among the best seaboats ever built. Her hull can stay in the water for weeks on end, requiring

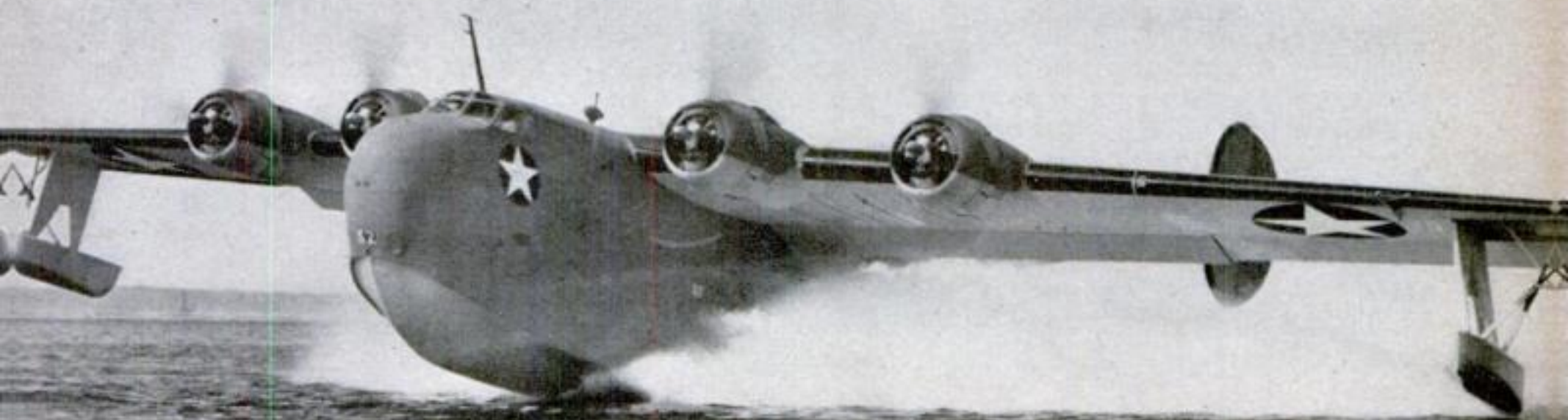
**WHAT YOU SHOULD
KNOW ABOUT OUR
FIGHTING PLANES**

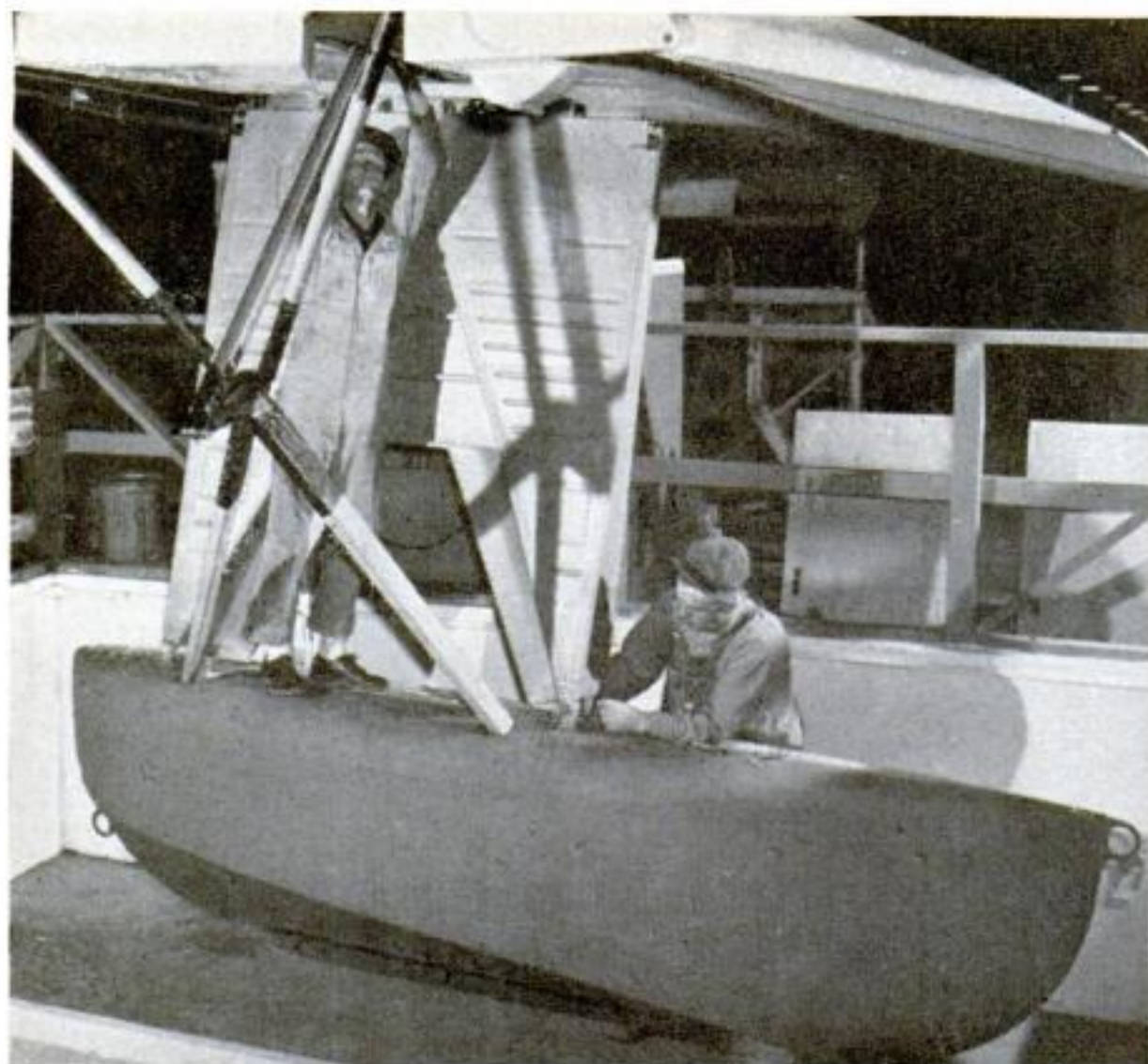




Catalina Like a big, ungainly flying fish, the PBY-5 waddles through the air on its "fly and look" missions as one of the eyes of the fleet. (Photo by Harold Kulick.) At the left it appears in its amphibian version, PBY-5A. That ugly snout has poked into a lot of trouble

Coronado Big sister of the "Cat" is the four-engine PB2Y-3. A cargo-carrying version, the PB2Y-3R, is used by the Naval Air Transport Service to carry personnel and supplies





Assembly-line workers attaching a stabilizer float to the wing of a Coronado. Like her famous sister, the PB2Y-3 folds up her stabilizer floats to form the square tips of the wings during flight, decreasing the drag

only cursory service. She waddles through heavy weather, ever prowling in search of German and Japanese warcraft. One found the German battleship *Bismarck* and hung on grimly, riddled by gunfire but not downed, until British forces could be dispatched to destroy the Nazi battleship. Others have torpedoed Japanese war vessels, bombed Kiska hundreds of times, and helped hold the Nazi submarine menace in check from bases in Great Britain.

Now, confounding enemy and American airmen alike, the Cat engages in dive-bombing sorties, screaming down at the unheard-of speed of 250 knots. Pilots drop bombs by the "seaman's eye" method, then apply the strength of four arms to pull her out into level flight.

Resting on the beach or in the water, the Catalina, known by the Navy as the PBV-5 (flying-boat version) and the PBV-5A (amphibian) reminds you of those other prewar boats which have been outmoded by the sleek craft of 1943. Unlike those other relics of the past, she can fly over enemy-infested waters for a total distance of 2,520 miles, starting with 1,463 gallons of gas in her tanks and loaded with bombs or torpedoes and ammunition for her .50 caliber guns.

But she can't reach enemy targets and escape the withering fire of Zeros and Heinkels with the sureness of a much faster

and more modern land bomber. In fact, she can't escape at all, except by hiding in the clouds and mist. Her gunners must man their weapons and try to outshoot enemy attackers, for a top speed of 185 m.p.h. gives them no other choice.

Yes, the Cat must fight to survive. And somehow, miraculously, as a breed she continues to live, snooping through the Aleutians' perpetual mists, night-hawking over the Southern Pacific to smell out Jap concentrations, blasting subs in the Mediterranean and Atlantic, and bringing back alive many Yankee pilots, who, shot into the sea, would otherwise perish.

There were few Cats in the Aleutians when the battle for their occupancy began early in June, 1942. Losses were heavy as the Navy brought in more PBV's and threw their crews into the fight to protect Alaska. Many winged westward into the murk and never came back. But their crews performed miracles of bravery. On June 10, a Cat found the first Japanese ships in Kiska Harbor. The very next day, another, poking its blunt snout through snow and rain, reported Japanese landings at Attu.

How many Cats were lost in the Aleutians may not be known for many months, but the crews never wavered. Pilots of Patrol Wing 4, shortly after Dutch Harbor was first attacked, began bombing Kiska as regularly as a clock ticks. For three days they pestered Kiska through rains of anti-aircraft fire, destroying 65,000 tons of shipping. One pilot beached his Cat after reporting briefly, "Ship now land plane. Hull no longer waterproof."

The Navy's high command looks upon these outmoded crates as offensive weapons, no matter what their limitations. Pilots and crews know that their very slowness makes them excellent targets for both anti-aircraft fire and enemy aerial gunfire. One flyer in the South Pacific radioed his commander, "Am shadowing (the enemy). Notify next of kin." Ten minutes later he was dead.

Shortly before dawn on June 3, 1942, Ensign Jewell Reid, of Paducah, Ky., left Mid-

way on a routine patrol. By midmorning, his Cat had covered several hundred miles in a westerly direction, when he sighted on the horizon several objects he did not immediately identify. Reid swung the ship about, moved in for a look-see, identified them as a Jap fleet, reversed his course to check their direction and speed. Then his voice spoke into the radio, warning of the intended attack on Midway. That night a squadron of other Cats commanded by Lieut. Gaylord D. Propst, partly protected by darkness, launched torpedo attacks against Japanese transports—the first time these boats ever had been employed as torpedo planes.

I. M. Laddon, vice president of Consolidated Vultee Aircraft Corporation, scarcely dreamed that these long-range boats would play major roles in war when he designed the first of the long line in 1933. He wove into their metal and fabric qualities of long range, durability, and comfort, plus capacity for bomb-carrying. Two 800-horsepower engines powered the first boat. Today's Cats duplicate the prototype, with the exception of three major changes. A pair of

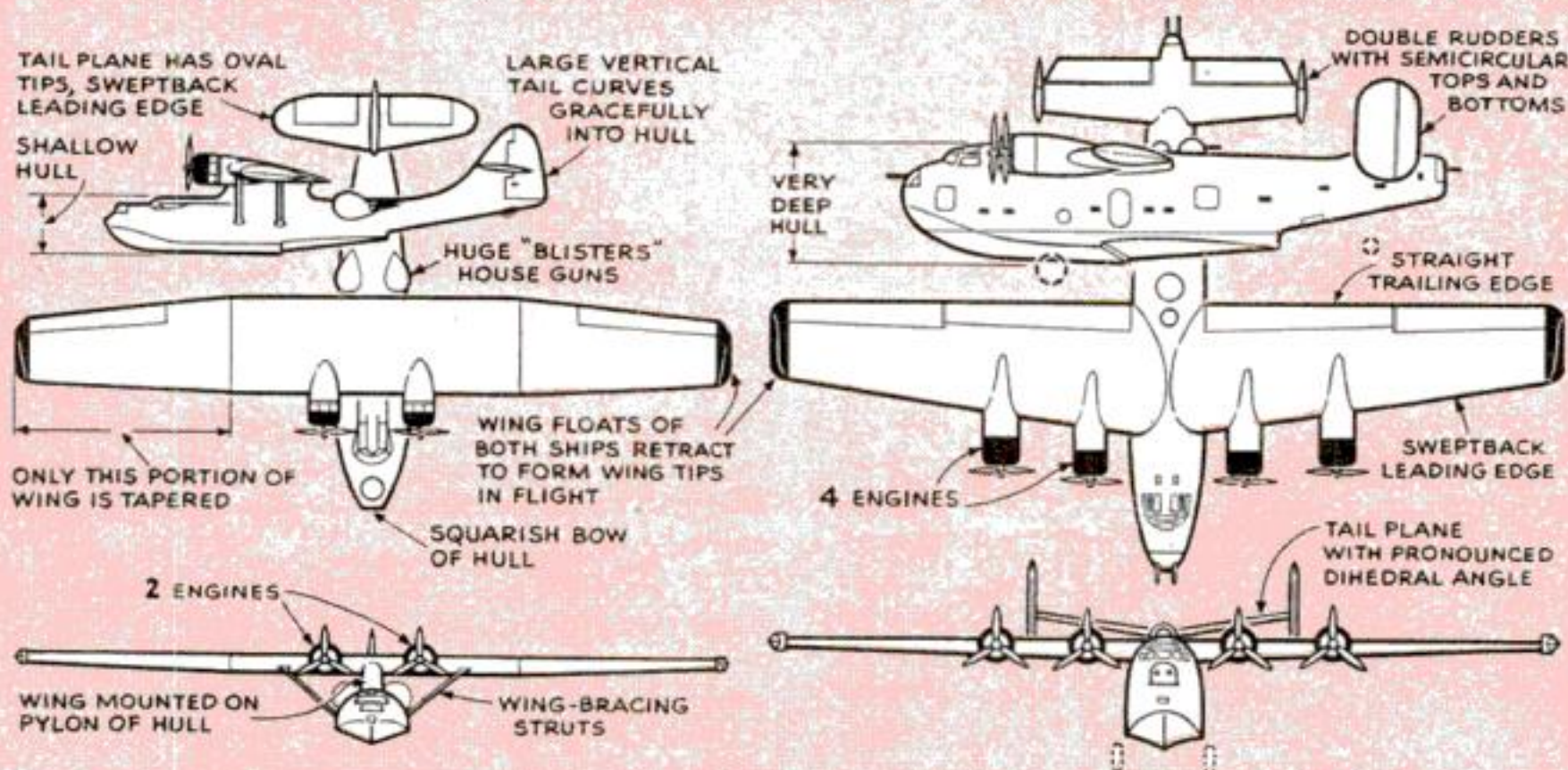
1,200-horsepower Pratt and Whitneys fitted with hydromatic propellers haul them skyward now, and two blisters on the sides of the fuselage give the gunners a chance to protect themselves against enemy gunfire.

Laddon built well. In 1937 the Navy, officially recognizing the worth of patrol planes for scouting purposes, transferred all scouting-force destroyers to the battle force, and all patrol-plane squadrons to the scouting force.

Ten years is a mighty long time in the life of a plane, and while the Cats promise to give added years of service, their "big sister," the 33-ton Coronado long-range patrol boat, is now in production. These combination aerial battleships and cargo-personnel carriers take shape on a four-part moving production line, making them the largest mass-produced flying boats now in the U. S. naval service.

Known in the combat version as the PB2Y-3 and the cargo carrier as PB2Y-3R, the Coronado can fly long distances on patrol or to carry needed goods to distant battle areas. Under and in the wings of the PB2Y-3 may be tucked several bombs and

TWO OF A KIND: COMPARISON OF CATALINA AND CORONADO



Catalina

PBY-5 (PBY-5A Amphibian)
Two P. & W. 1,200 hp.
104 ft.
63 ft. 10 in.
18 ft. 10½ in.
35,000 lb.
Five
185 m.p.h. (7,500 ft.)
3,100 mi. (flying boat)
Long-range patrol bomber

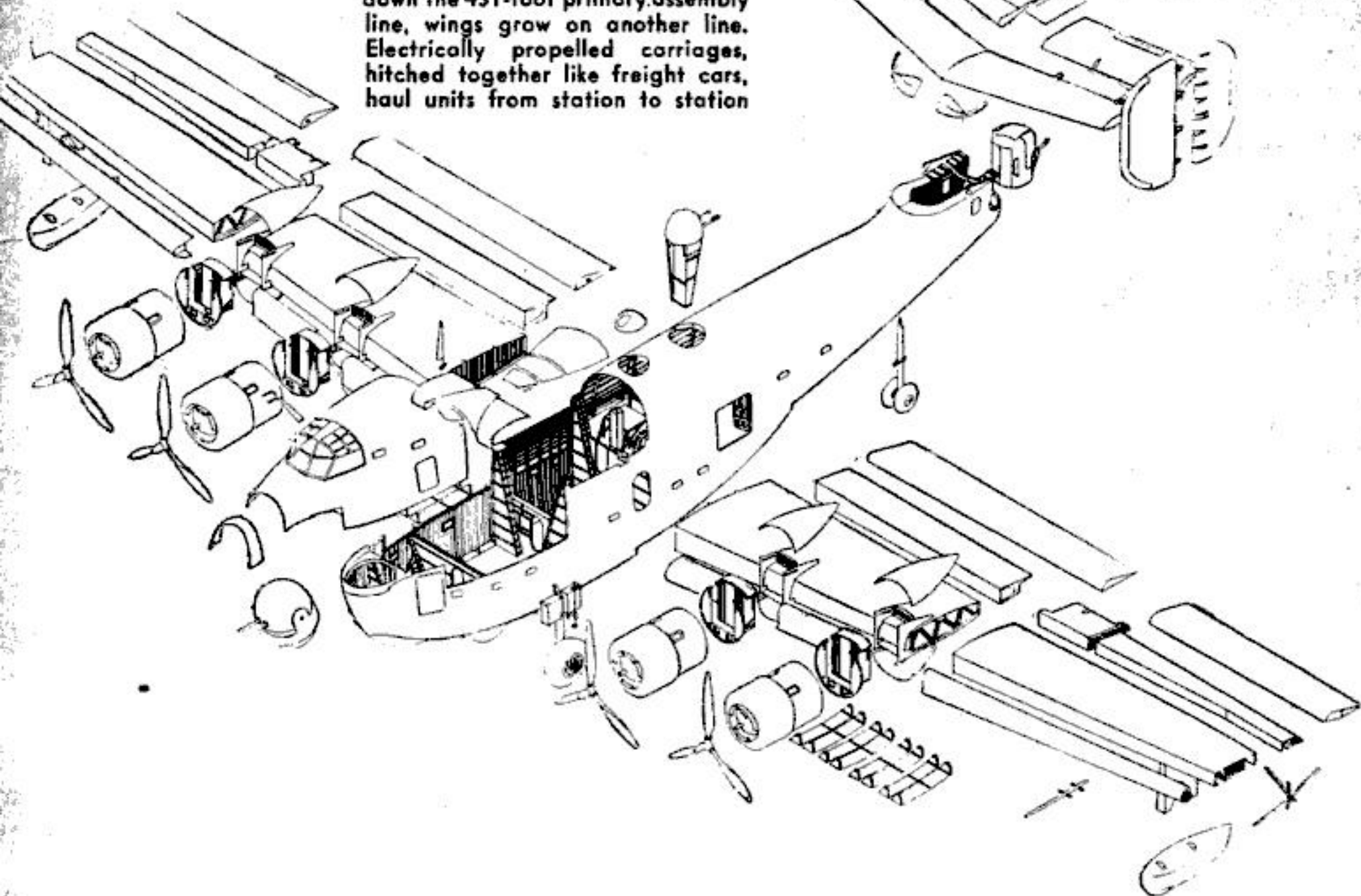
ENGINES
WING SPAN
LENGTH
HEIGHT
GROSS WEIGHT
CREW OR PASSENGERS
MAXIMUM SPEED
RANGE (LOADED)
DUTIES

Coronado

PB2Y-3
Four P. & W. 1,200 hp.
115 ft.
79 ft. 3 in.
27 ft. 6 in.
66,000 lb.
Ten
Over 200 m.p.h.
2,940 mi.
Long-range patrol bomber

ASSEMBLING A CORONADO

Largest mass-produced flying boat in U. S. naval service, the 33-ton PB2Y takes shape on a four-part moving production line at the Consolidated Vultee San Diego plant. While fuselages move down the 431-foot primary assembly line, wings grow on another line. Electrically propelled carriages, hitched together like freight cars, haul units from station to station



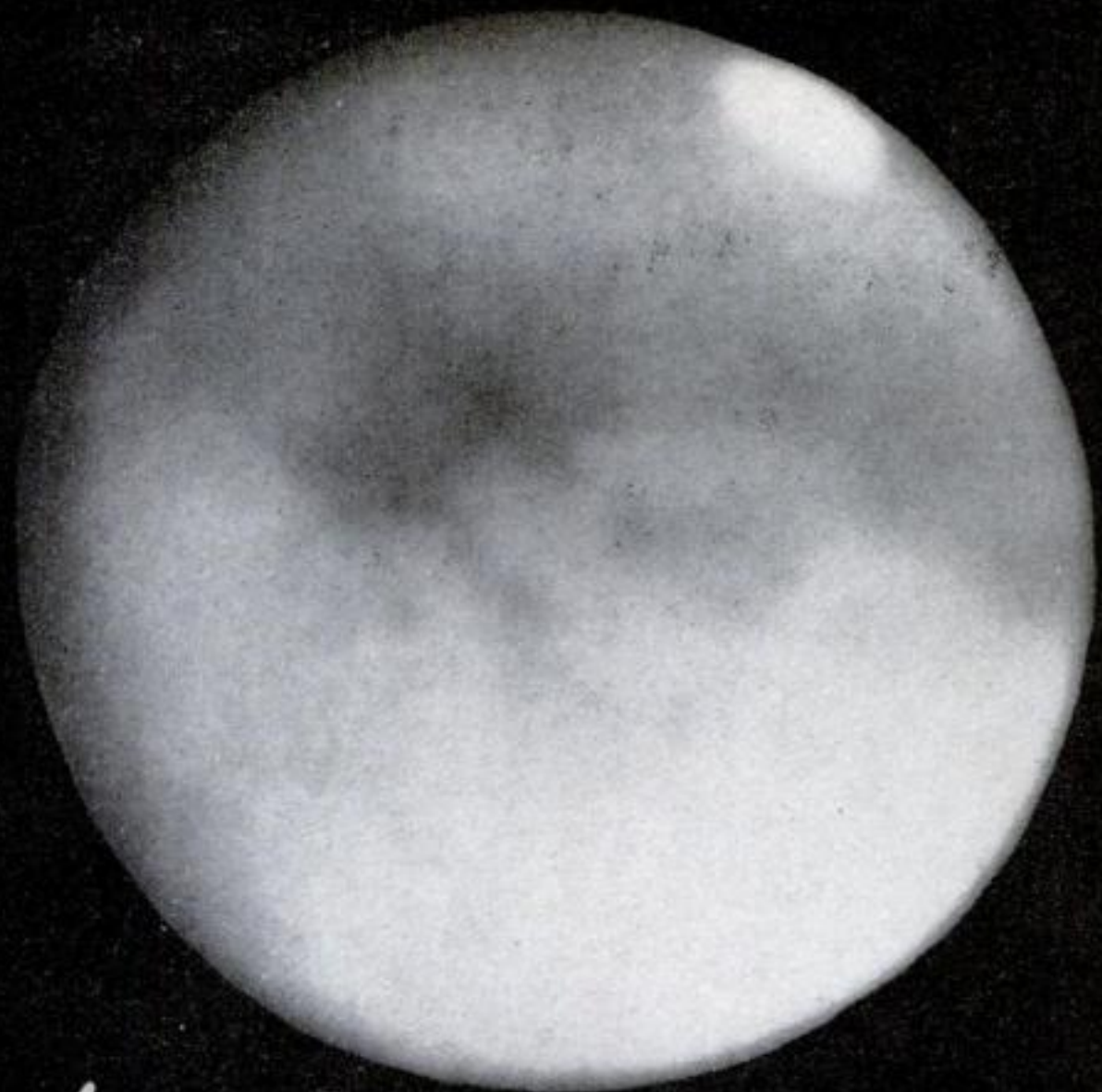
torpedoes, or a six to eight-ton bomb load. Up to 5,000 pounds of cargo may be carried long distances with a heavy gasoline load.

The Coronado is a complex mechanism. Her crew of ten, living and working in seven main compartments on three decks, operate .50 caliber machine guns mounted in turrets placed in the nose, tail, and amidships; drop their loads of bombs and torpedoes, and prepare their reports while over the sea. To facilitate take-offs and increase her speed during flight, the hull has two steps and a semicircular top, and the all-metal after step terminates in a vertical knife edge, which aids the boat in breaking away from the water and holds it on course before take-off. As on the Cat, stabilizing floats retract during flight to form the square-tipped wings. Twin fins and rudders, large and set high, and a stub nose make the boat easily recognizable. The wing sweeps backward along the leading edge and carries a ruler-straight trailing edge.

You haven't heard much about these big boats, because they have been assigned primarily to look and listen and carry big loads without being trapped by the enemy. Their names will appear more frequently

in the future, though, for new jobs are constantly being found for the big sisters. Right now the Navy Department is expanding its Naval Air Transport Service from three to 10 squadrons. Seven already have been commissioned. This means more Coronados will join the network which last year covered 50,000 miles of routes. A recent \$40,000,000 Congressional appropriation promises the network will be tripled, with personnel and cargoes destined for battle being transported all over the world, from Australia to Africa, from Iceland to Rio.

Recently another sister boat was announced. This is the Model 31, to be known as the P4Y—a twin-engine, long range patrol boat which the Navy considers the fastest flying boat ever built in America. Fitted with the famed Davis wing, which helps give the B-24 Liberator greater speed and lift than most bombers her size, the newest of the Cat family has been designed for both combat and patrol duty. Carrying a crew of seven, she is powered by two 2,000-horsepower engines, measures 74 feet long, stands 25 feet high, and weighs some 50,000 pounds. When she arrives, the Cats will take a new lease on life.



New Light on **THE MYSTERY OF MARS**

**DOES LIFE EXIST ON OUR NEIGHBORING PLANET?
A DISTINGUISHED ASTRONOMER WEIGHS THE ODDS**

By DONALD H. MENZEL

*Professor of Astrophysics at Harvard University,
Now serving as Lieutenant Commander, U.S.N.R.*

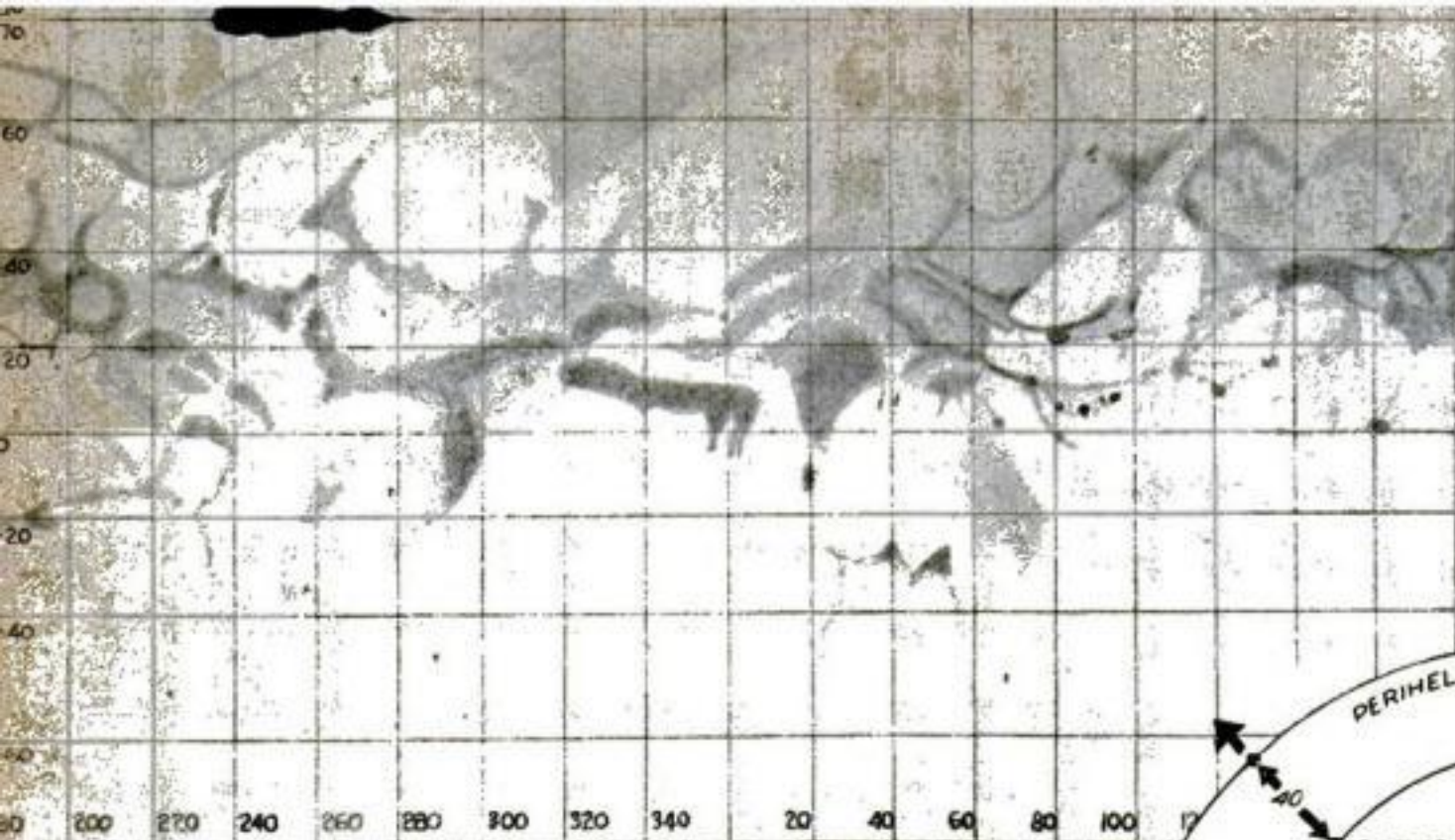
★ **MARS**, for the average person, is a planet endowed with romance and mystery. Scientists, fiction writers, and comic-strip artists have unwittingly co-operated to popularize the belief that Mars must be inhabited. Several years ago Orson Welles and his Mercury players threw a scare into New York and New Jersey by their vivid broadcast of H. G. Wells' famous mystery, "the War of Worlds," which dramatized an invasion of the earth by the Martians.

Everyone, it seems, is ready—almost anxious—to find facts tending to confirm the view that there is life on Mars. And this life, to be interesting, must possess human—or, preferably, superhuman—qualities. The argument often heard is, "If there are so many suns, is it not certain that some of them may possess planets, and that at least a few of these planets are inhabited?"

There are too many unsolved problems connected with the question for scientists to attempt a reply. For example, until we know definitely how our own solar system came into existence, it would be foolish to hazard a guess about the universe in general.

But Mars is a slightly different story. It is part of our own system—a brother planet—heated and lighted by the same star, our sun. Its evolution must have had some relationship to that of our earth. It is close enough for us to see markings upon its surface. We can measure its temperature, study its color and changes. We see its atmosphere. Surely we have a chance to attack the problem of Mars from a purely scientific angle.

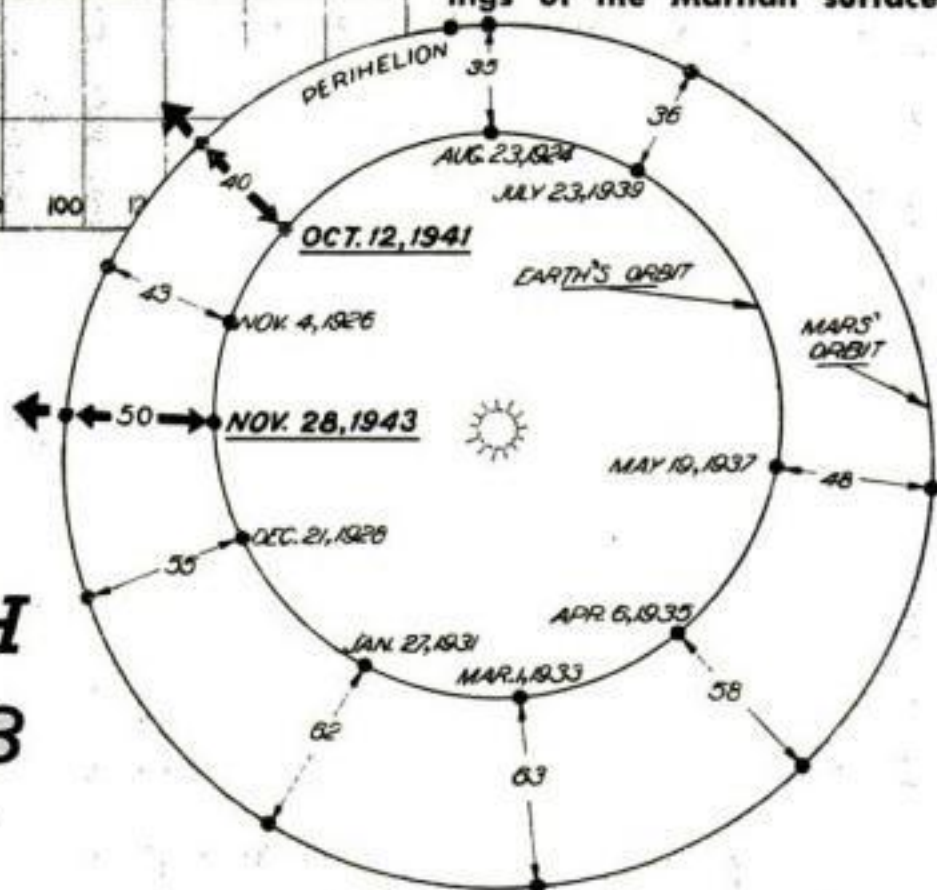
Observations of Mars made prior to 1877 had established the fact that Mars possessed permanent or semipermanent green markings on an orange-pink background. The planet was known to rotate on its axis in a little more than 24 hours, so



During the current war, valuable astronomical information, relating particularly to the planets, has been received from France where, atop the 10,000-foot Pic du Midi in the Pyrenees, three astronomers, Lyot, Gentili, and Camichel, made drawings of Mars during the planet's opposition in 1941. These drawings, such as the one at the left, have aided scientists materially in reinterpreting the highly controversial markings of the Martian surface.

Because it follows a somewhat eccentric orbit about the sun, Mars every 25 months swings in toward the earth. The distances of these approaches vary from about 34 to 64 million miles. The next approach, due to take place November 28, will bring Mars to within 50 million miles of the earth. For a month preceding and following, it will appear brilliantly in the sky—and astronomers all over the world will be squinting through huge telescopes, trying to solve its mystery.

WATCH NOV. 28 1943



that in this respect, at least, it closely resembled the earth. Its gray-green areas were thought to be oceans, and its orange areas, land. At either pole of the planet there appeared white areas which, keeping step with the marching seasons, were recognized to be polar caps composed of ice, snow, or possibly hoarfrost. The suggestion that one occasionally hears, that the caps are composed of carbon-dioxide snow (dry ice), is untenable. This substance could not possibly solidify at the low pressure of the Martian atmosphere.

In 1877 the famous Italian astronomer Giovanni Schiaparelli discovered that the disk of the planet was covered with a network of fine lines. To these lines, which Schiaparelli carefully mapped, he gave the name "channels," or in Italian "*canalli*." Schiaparelli probably thought of these channels as containing water, but it remained for his followers to translate the word into English as "canals," and thereby imply an arti-

ficial origin, with an intelligent life of some sort or other inhabiting the planet.

In 1894 Percival Lowell founded an observatory in Flagstaff, Ariz., which he dedicated chiefly to the study of the planets, Mars in particular. Lowell's drawings of Mars were more than a confirmation of those of Schiaparelli. The network proved to be even more extensive than other observers had supposed. His observations further checked those of Harvard's William H. Pickering, who had pointed out that the gray-green areas also were crisscrossed by the network. These areas, therefore, could not be bodies of water.

Lowell was particularly struck with the apparent straightness of the lines. He reasoned that the formations could scarcely have come about through accident, and suggested that they represented a system of canals, built by an intelligent race to bring water from the polar snows to the temperate zones. This theory of Martian habitation

CANALS The one feature of Mars that is most often used to buttress the theory of intelligent life on the planet is its network of straight lines. Discovered in 1877 by the Italian astronomer Schiaparelli, these lines were first described as "*canalli*," or channels. In translating the Italian word into English, however, Schiaparelli's followers used the term "canals," there-





A CLOUDY MARTIAN AFTERNOON

These photographs of Mars, taken at intervals over a period of about four hours, show the formation and growth of a cloud (indicated by arrows). Between the first and last exposure — from afternoon to sunset — the planet revolved 55 degrees, its rotational direction being upward and to the left

Photos by Dr. W. H. Wright, Lick Observatory

met with wide public acclaim, although scientists did not accept it. For many years a controversy raged about Lowell's observations and his conclusions. The results have been a general confirmation of most of Lowell's observational facts.

Although photography has played an important part in recent studies of Mars, it has not been as satisfactory as the human eye in recording the fine details of the structure of the Martian surface. The eye can take advantage of those fleeting moments of seeing conditions when the minutest details upon the planetary surface flash out and then disappear in the atmospheric tremors that produce the twinkling of the stars. The photograph, with its time exposures, is always subject to these atmospheric disturbances.

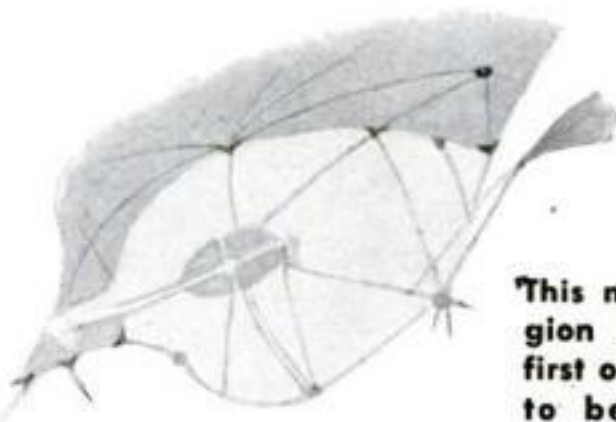
The picture that the astronomer can give of the Martian surface, however, is at best fragmentary. The observations are far from definite and it is very easy to be led astray. Few astronomers agree on all details. The following picture, then, represents the *present personal* viewpoint of the author and in no wise is to be regarded as the definite and final word on a vexing problem.

To obtain a full picture of Mars and the significance of the various markings upon its surface, we shall have to go back in history more than a thousand million years, to the time when the solar system was young. At that time it is probable that Mars

possessed both more water and more atmosphere than at present. There may have been extensive vegetation, and oxygen may have been an abundant constituent of the atmosphere. We cannot say with certainty. But Mars, smaller than the earth and with a much lower gravitational attraction, was unable to hold its original atmospheric envelope, most of which evaporated away into space. The oceans, too, have vanished, part of them into space and part of them into the interior of the planet. I regard the present gray-green areas as ancient ocean beds. The so-called "canals" I believe to be ancient river valleys.

At present the only vegetation existing on Mars is to be found in the low river valleys and in the ancient ocean beds. Water is now a scarce commodity on Mars, and the last traces of it appear only in the lowlands and at the polar caps. The remaining portion of Mars is arid. Although at one time it may have been fertile country, those areas have now reverted to desert, like the Painted Desert of Arizona. The predominant orange-pink color of Mars is due to sand—sand filled with iron rust. The small amount of vegetation still remaining on Mars is in no wise

sufficient to replenish the oxygen, which has disappeared from the original atmosphere and has gone into combination with the
(Continued on page 206)



This map of Mars' "Lake of the Sun" region shows the small triangular spots first observed by Lowell, and now thought to be the deltas of dried-up rivers

CHANGES that occur in the surface markings of Mars are seen in these three photographs. The first was made with an orange filter in September 1909; the second and third, by infra-red light in September 1924 and November 1934.



Leveling Out the

SHOCK ABSORBERS LEAD A TOUGH LIFE—CHECK THEM

By RALPH ROGERS

IF YOU are "rough-riding" to work these mornings because of "hard steering" or wheel shimmy, or because your car "dances" on the road, you had better check your shock absorbers—the front ones for steering and shimmy, the rear ones for "dancing." Defective shock absorbers also permit the car to bounce too much, thereby causing the wheels to spin without gaining traction. This not only wastes gas, but scuffs away precious rubber.

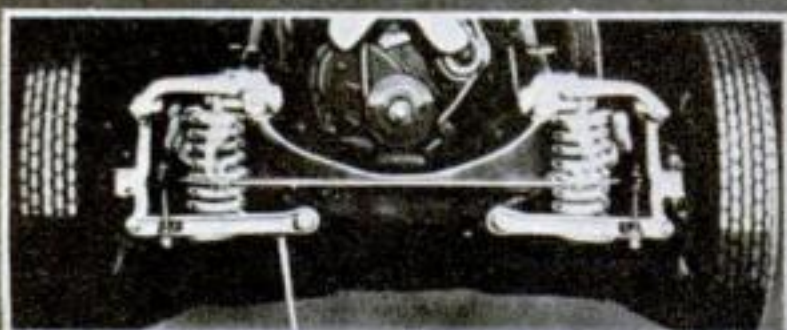
A quick check on how your shock absorbers are functioning is to bounce the wheels, one at a time. If the units are defective, the car will continue to bounce after the initial shock. For a more positive check, disconnect the shock absorbers, and move the arm of each through its complete

stroke. If there is little or no resistance, you may be sure that the unit is in need of servicing. Do not, however, disconnect the "knee-action" type, because you may destroy the wheel alignment and let yourself in for a major job. Also, before making a detailed check on shock absorbers as the cause of hard riding, investigate tire pressures first and see that springs and spring bolts are properly lubricated and that they work freely.

The majority of today's shock absorbers are hydraulic, and when they become defective it is usually because the fluid is low. When the fluid gets low, air pockets form in the working chambers and destroy the effectiveness of the unit—a common fault.

On all except aero-type units, fluid level can be checked readily by removing the filler plug, usually located at or near the

AUTOS



KNEE-ACTION FRONT WHEELS



FRONT RIDE STABILIZER



FRONT AND REAR SHOCK ABSORBERS

Rough Spots ...

FOR SMOOTHER RIDING AND SPRING PROTECTION

top of the unit. If the fluid level is below the bottom of the filler plug hole, shock-absorber fluid should be added. It is wisest to use the one recommended by the manufacturer.

The fluid level in direct-acting aero-type shock absorbers cannot be checked in this manner. Here the quantity of fluid depends on the size of the unit, and the manufacturer's specifications should be followed exactly in order to obtain satisfactory results because the shock absorber will be damaged if filled with too much fluid.

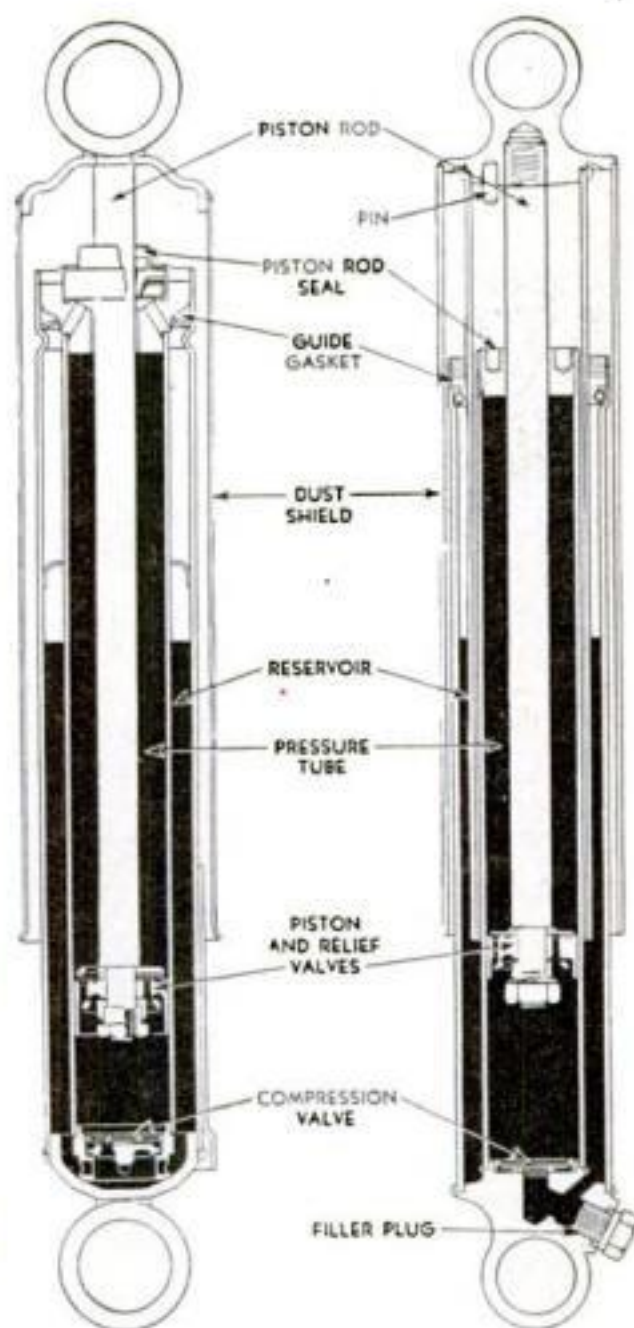
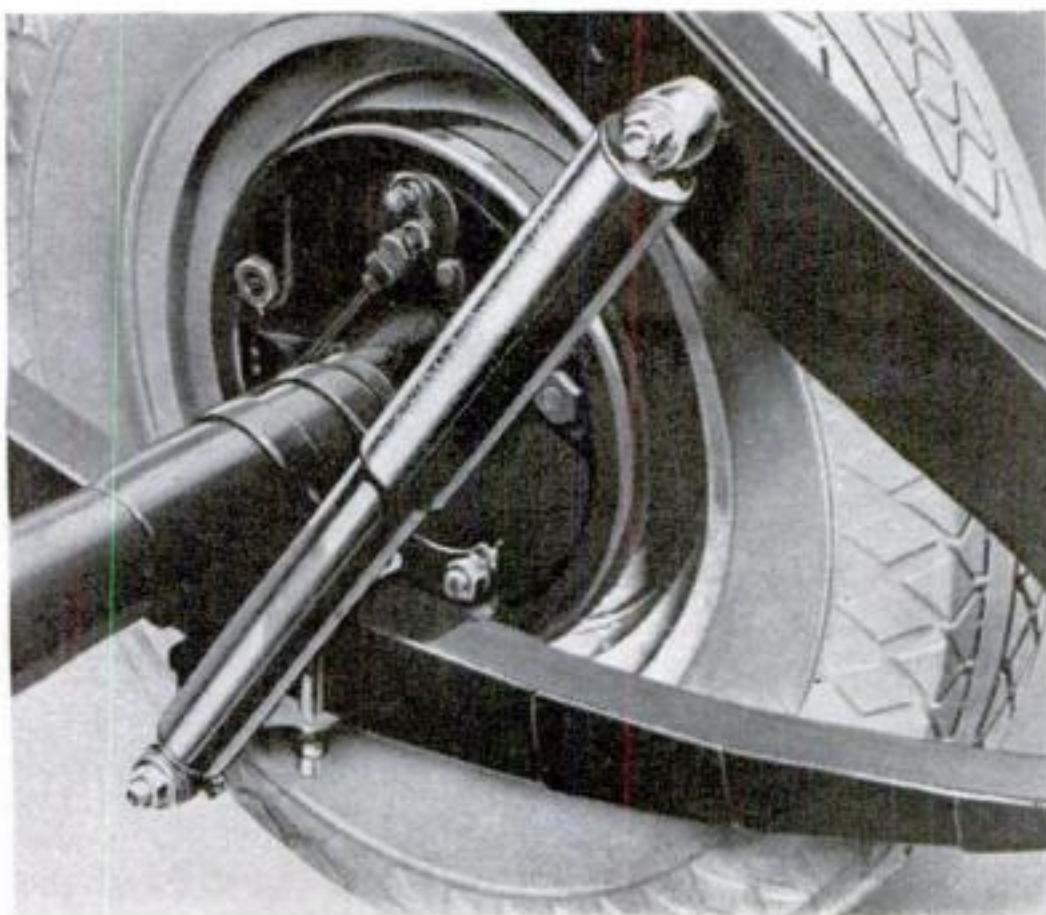
Aero units are filled by removing them from the car. Clean away all dirt from around the filler plug and pull the shock absorber to its fully extended position. Take out the filler plug and remove all the fluid by pumping the piston back and forth until the unit is empty. With the shock absorber

horizontal, clamp the filler-plug end in a vise (but not on its tubing) with the hole facing upward. Now collapse the unit to its shortest length and, with measuring cup and funnel, fill it. Pull the unit to its fully extended position, and move it back and forth until the exact amount of fluid is worked well into it. Then replace the plug and put the unit back on the car.

Direct-acting aero units without filler plugs must be completely disassembled in order to fill or service them. If you are not equipped for this job, it is better to exchange the old unit for a rebuilt model or to have the work performed by a regular shock-absorber serviceman.

More important even than the low fluid level is the cause of the loss of fluid. Leakage, which most often is responsible, can be detected by the presence of fluid on the out-

Direct-acting aero-type shock absorbers are shown here in cross section and mounted at the rear of a car. They are double acting and absorb both the upward and the downward movement of the car. When refilling them, be sure to use the exact amount of fluid recommended by the manufacturer. In assembling them again, clean all parts thoroughly and inspect them for nicks and burrs. For a smooth performance, install valve parts perfectly flat



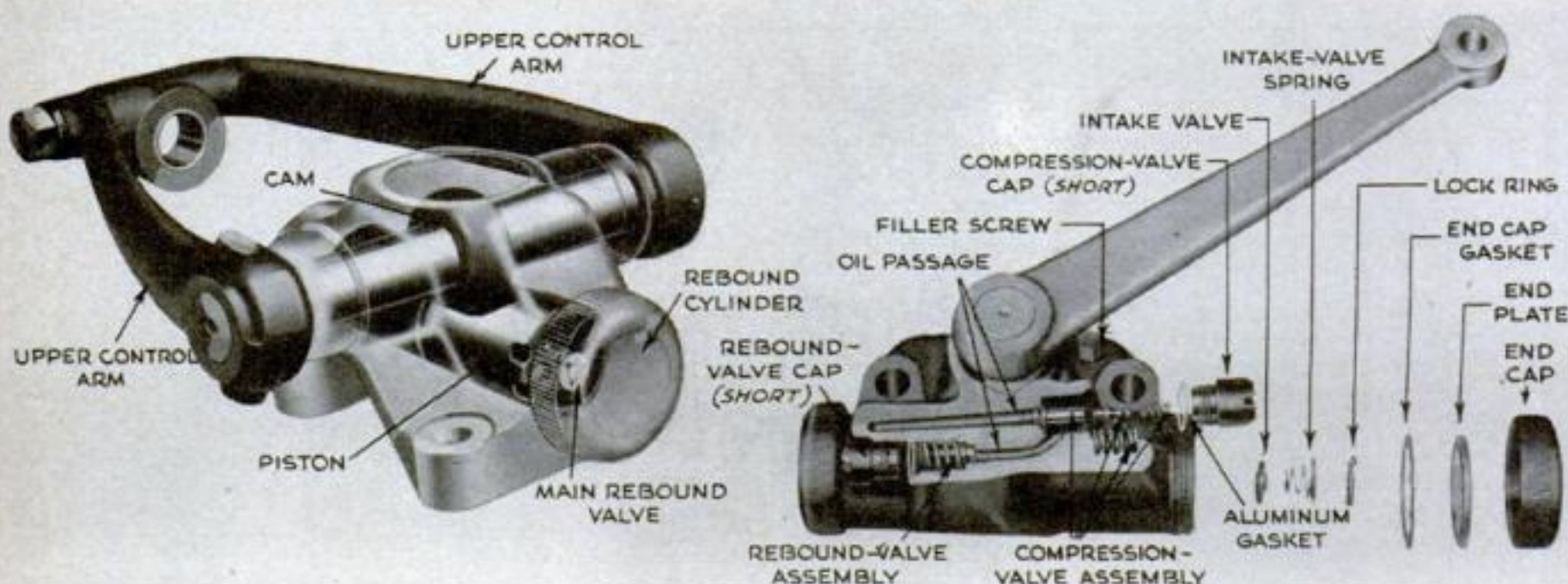
side of the shock absorber. To locate the leak, clean the housing thoroughly, fill the unit to proper level, and drive the car over rough ground. A second inspection will show the leak. Note especially all gaskets—particularly the end-cap gasket on the inner side of double-acting units and that at the filler plug. An initial leak at the seal end on single and double-acting units where the shock-absorber arm goes through the housing is to be expected because of fluid expansion. However, if there is a leak at any of the end caps or valves, new gaskets should be installed and the unit cleaned and tested again. The slightest leak at the end cap will empty the shock absorber within the first few miles of driving.

An even more serious leak may be due to worn packing washers, especially if the unit has been operating with too little fluid. Leaks around the shaft are warning signals and can be corrected only by replacing the shock absorber. You need a service man to correct a leak in a direct-acting aero-type shock absorber, as the unit must be dismantled in order to make the repair.

Noisy shock absorbers are usually the result of looseness somewhere in the linkage. However, when investigating, check and tighten the entire shock-absorber mechanism. Make sure that the brackets are tight and the shock absorber is not rubbing against anything. Replace any worn rubber mounting bushings and make sure that the shock-absorber arm is tight on its splined shaft. After you have done this, if you still get a rattle or squeak, the entire assembly should be checked by a competent mechanic who is equipped to make a thorough inspection.

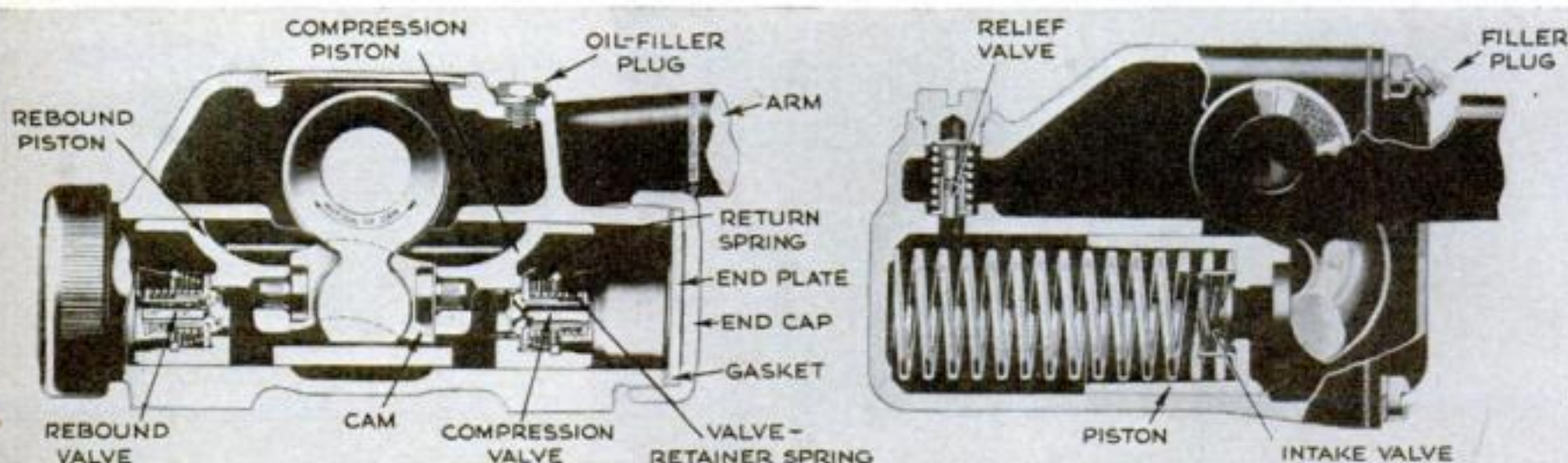
Before you blame the noise on the shock absorbers, however, check the rest of the car, especially for worn or broken stabilizer links and bushings, loose brake rods, loose spring shackles or covers, loose fenders or bumpers—and even for tools bouncing around in the trunk.

If you still are "rough-riding" after all this, then the tension on the shock-absorber valves should be changed. This also is a job for a competent shock-absorber serviceman, not for the home mechanic.

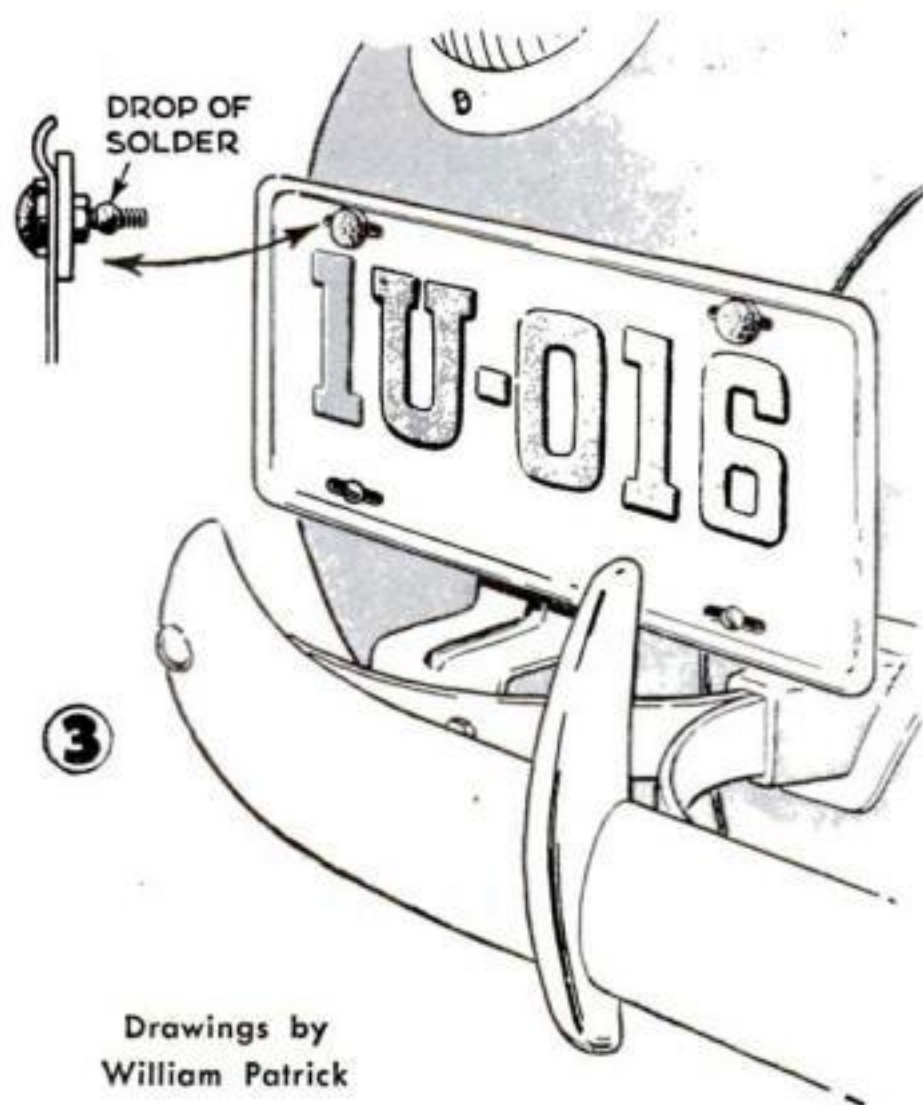
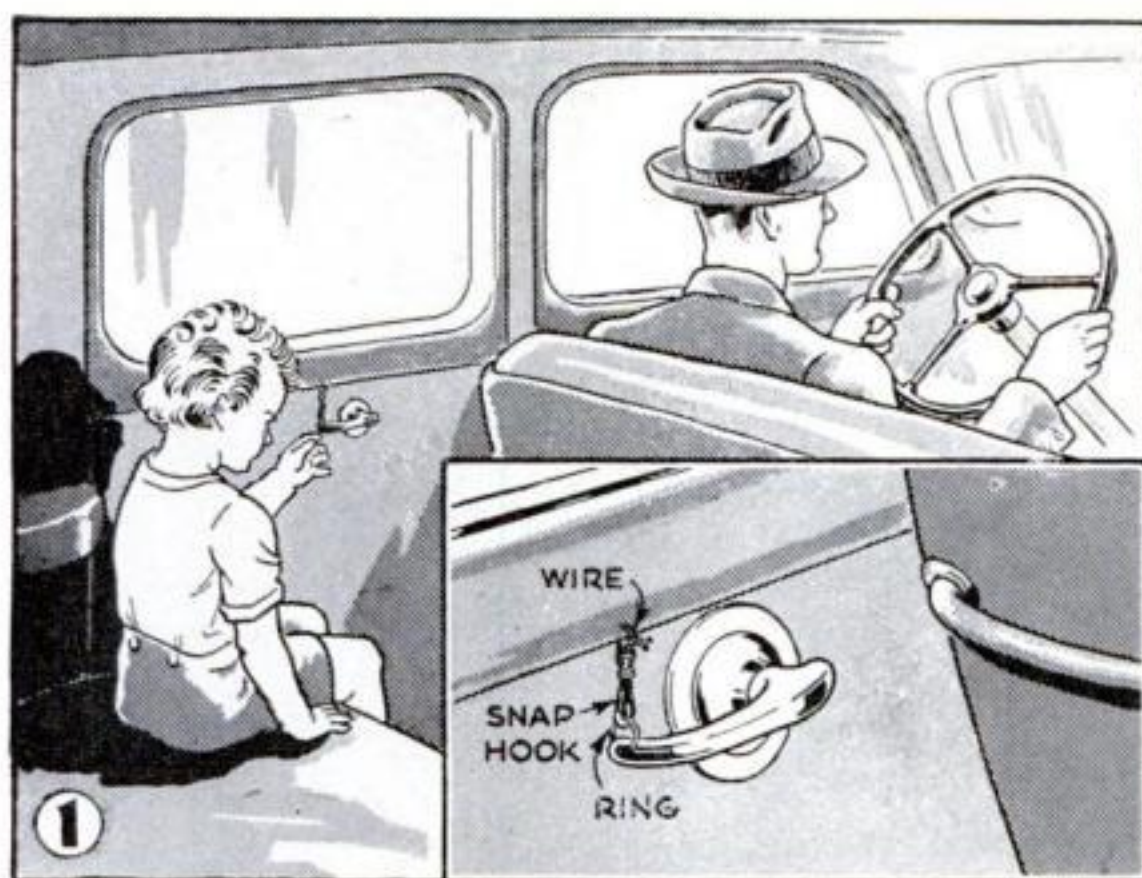


Above is a phantom view of a double-acting shock absorber of the cam-and-lever type. Below, it is shown on the down stroke with the rebound valve absorbing the shock. When the car hits a rut, up-stroke action is taken up by valve compression

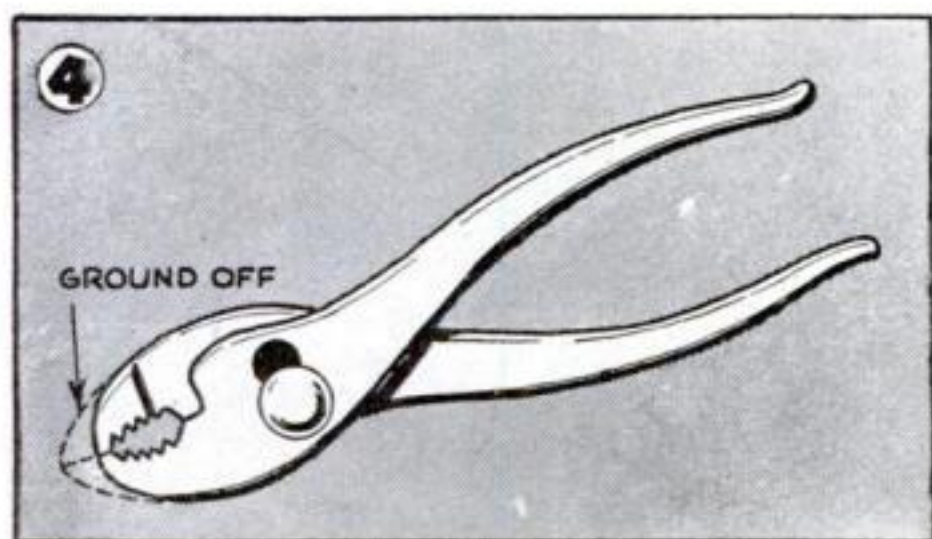
An exploded view of another cam-and-lever model having double action. This one, unlike that at the left, is serviced through the end cap on the housing. Below is a single-action cam-and-lever type that will control shock on the rebound only



USEFUL AUTO HINTS



Drawings by
William Patrick



1 A DOOR GUARD FOR CHILDREN left alone on the back seat of a four-door sedan can be rigged easily with a split ring and a snap hook. Drill the door handle near the end and fit into the hole a $\frac{1}{4}$ " diameter split ring such as is used to carry keys. Directly above, drill a hole in the window frame for a small, stiff wire. Pull the wire through the hole and the loop of a snap hook. Twist the wire tightly together and solder the end to cover any sharp points. Fasten the snap hook into the ring. The door opens from outside, and adults can unfasten the snap, but it baffles small children.—E. B. A.

2 YOUR TIRE GAUGE can readily be adapted to give an accurate pressure check when used in dark places. Simply file a small notch in the indicator at the correct reading for the standard pressure for your tires. The notch can be felt in the dark and does not interfere with the operation of the gauge.—J. R.

3 REFLECTOR-BUTTON THIEVES, usually small boys who want the bright buttons for their bicycles, can be thwarted by putting a drop of solder on the bolts that hold the license plates. This is better than crimping the threads, as the solder can be removed at home with a blowtorch or a hot soldering iron.—J. B.

4 THIS BATTERY TOOL for loosening terminals can be made by grinding down the nose of a pair of common pliers. The standard nose is too long, interfering with a good grip, while the shorter nose allows closer work and will not mar the battery.—C. L. L.

Gus Solves the



... sneaked up with a knife as he slept at the counter

By MARTIN BUNN

GUS WILSON had just started work on his first job of the morning when State Trooper Jerry Corcoran came briskly into the Model Garage shop. As always, his gray-blue uniform was immaculate, gleaming boots competing with the luster of his Sam Brown belt, his broad-brimmed felt hat tilted at its habitual jaunty angle. But Gus saw that he was worried, that his gray eyes were tired.

"Hi, Jerry!" he greeted him. "Hear you had a murder on your beat last night."

Jerry perched himself on the end of the workbench, fished a pack of cigarettes out of his breast pocket, and lighted one. "Yes," he said, "we did. George Oxdallas . . . in his juke joint. . . . It was me who found him."

"Shot?" Gus asked.

"Nope. Throat cut." Jerry wrinkled his nose at the recollection. "As near as we can figure it out, he had fallen asleep behind his cash register, and the guy who got him sneaked up with a knife, reached around, and sliced him. Oxdallas had a gun in the counter drawer, but he never had a chance."

"Haven't you got anything to go on?" Gus wanted to know.

"Yes," Jerry said. "We've got a lot to go on—but the trouble is it doesn't add up. Look here, Gus—I'm going to tell you the whole story. Some of it's in your line, and maybe you can help me."

Gus lighted his pipe. "Shoot!" he advised briefly.

"First, about Oxdallas," Jerry said. "About the time the war plants opened, he sold a couple of coffee pots down in the city and started his joint up here. I guess he did all right—it's in a good spot, and a lot of the

boys and girls who get through at midnight stop by there."

"Sure," Gus agreed. "A fellow who works half the night needs a little recreation."

"Now we come to Con Constantine," Jerry went on. "Ever been in his pool room?"

"Young man," Gus said severely, "I'm a respectable citizen even if I'm not a family man, and I'm old enough to have the sense to keep out of back-street pool rooms."

"Sure," Jerry said, and grinned.

"Well it's a tough joint, and Constantine is a bad egg. He started off all right as an automobile mechanic, but he got mixed in a lot of shady deals—he's been pinched a half dozen times, down in the city, but he always got off."

"Now here's the important part. I passed Oxdallas's place about half past two this morning. I was on my motorcycle, guiding an Army truck convoy that was in a heck of a hurry. There were maybe a dozen cars parked in front, and I could see people dancing. Nothing unusual about that. But about a hundred yards below, pulled up in the brush on a dead-end lane, was a convertible coupe with the lights off. I'd swear it was Constantine's. He stops at Oxdallas's now and then. But why would he want to park up that lane instead of in front?"

Gus grunted, but said nothing.

"That kept bothering me," Jerry admitted, "but I had to guide the convoy to the city line. When I got back to Oxdallas's it was a quarter past three. The car was gone from the lane. So were the cars that had been standing in front. But all the lights were on bright, so I thought I'd stop in and see what was going on. . . . I've told you what I found."

Jerry reached inside his tunic and brought out two folded papers. He opened one and handed it to Gus. "That's a photograph, enlarged to life size, of a tire track we found up the lane."

Gus examined the print carefully. "It looks as if the tire had a worn spot on one side," he commented. "Chances are it was caused by scuffing, due to bad alignment."

Jerry grunted and passed Gus the second print. "That's the left front tire on Constantine's coupe," he said. He waited as Gus compared the two. "What do you say?"

"I'd say that Constantine's car made that

Case of the Brass Clue

track," Gus said. "It looks to me as if you have a strong case."

"To make it stronger," Jerry said, "we had a lab specialist up from headquarters, and he made a plaster cast of the track. Constantine's tire fits every indentation."

"Further than that," Jerry went on, "we can prove that night before last, in a stud game in his back room, he lost so much to some big city gamblers that it took every dollar he had to square up."

"Well," Gus said, passing the two prints back to him, "why don't you arrest him?"

"He's under arrest, all right," Jerry said. "But only for running a gambling joint. He has an alibi."

"'Sure I parked up the lane,' he said, '—to watch the birds. But it was yesterday afternoon. So what?'"

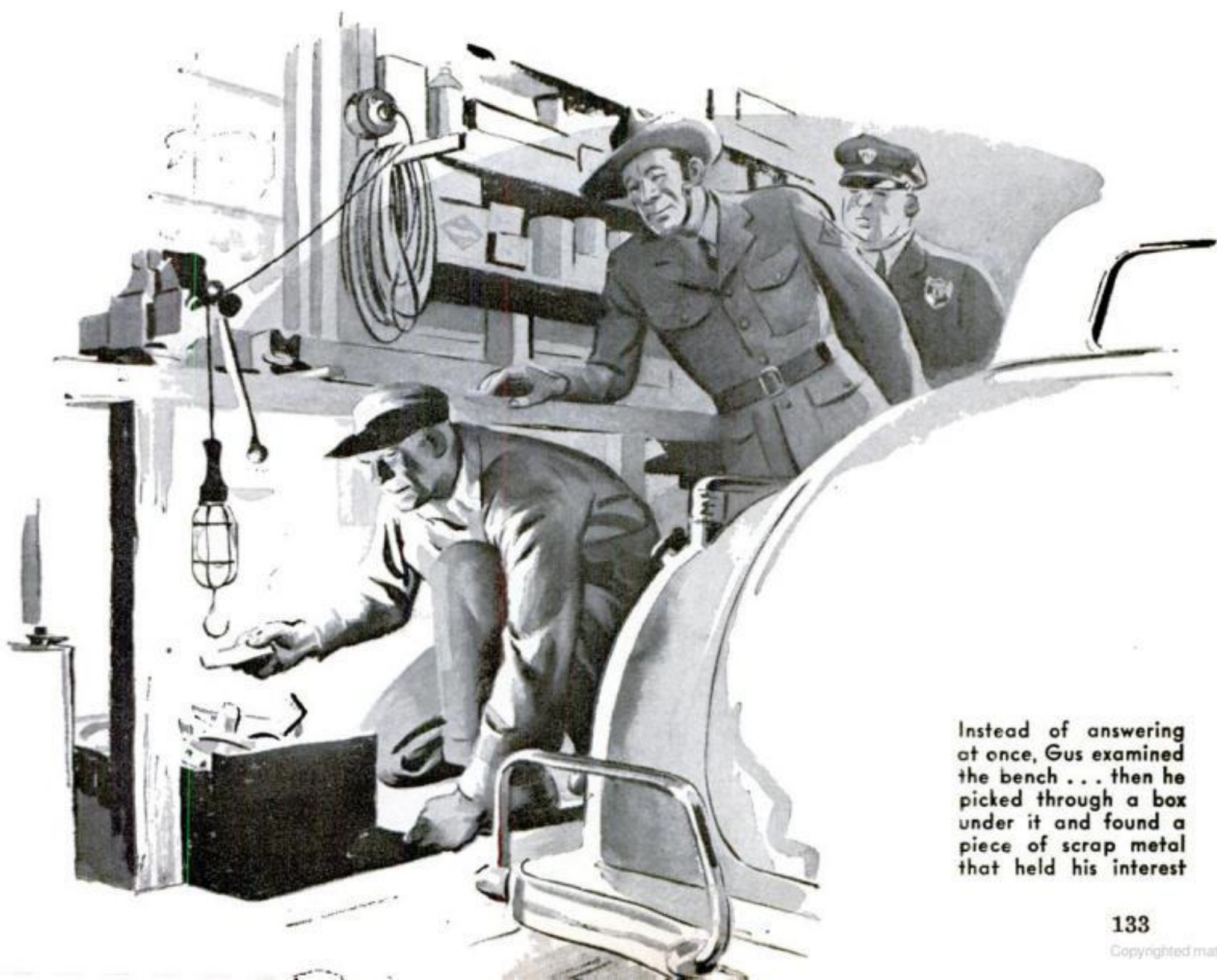
"Constantine claims that his car *couldn't*

have been there at half past two this morning—because when he tried to start it about eight o'clock last night something went wrong and it blew a spark plug right out of the cylinder head! Before nine o'clock he had called three garages trying to get a new cylinder head in a hurry, and when he couldn't find one, he told Joe Moss to order one from the city for him this morning. We checked on the calls, and it's true, too, that there's a spark plug missing from his motor. It looks as if it had been blown out the way he says it was—the threads in the spark-plug hole are ripped clean out. You can't drive a car with an open hole in a cylinder head, can you, Gus?"

Gus puffed at his pipe for a full minute before he answered. Then all he said was: "I haven't seen Constantine's car, Jerry."

Jerry grinned and slid down off the workbench. "Let's go," he invited.

Constantine's pool room was in what once



Instead of answering at once, Gus examined the bench . . . then he picked through a box under it and found a piece of scrap metal that held his interest

had been a fine residence; his garage, opening on a narrow alley, had been the stable. A policeman sitting on a box at the door grinned wisely as Jerry parked his car in the alley. Jerry led the way into the garage. Constantine's convertible coupe was standing there, its hood raised. There was a workbench with a few tools on it; shelves over the bench held spare parts and odds and ends. The place was clean and neat.

"This guy was a good mechanic before he turned crook," Jerry remarked. He pointed to the coupe's engine. "There she is, Gus. What do you make of it?"

Gus examined the engine carefully. One of the plugs was missing. He ran a forefinger around the circumference of the empty hole and found that all the threads, except the bottom one, were gone.

"Well, how about it?" Jerry demanded anxiously. "Do plugs ever blow out?"

"Once in a great while," Gus told him. "It's uncommon, but it does happen."

Jerry looked disappointed. "Then he *could* be telling the truth?" he asked.

Gus didn't answer. He went over to the workbench, and carefully examined everything on it. Then he did the same thing with the shelves. A couple of dust-covered taillight bulbs interested him, but after looking at them he put them back. Then he began going through scrap metal in a box under the bench. Jerry saw him nod when he picked up a small, flat piece of brass. He took it to the window, examined it carefully, nodded again, and put it in his pocket.

"What is it?" Jerry asked anxiously.

But Gus went back to the car. "Jerry," he said, after a pause. "You asked me if Constantine could have run this car with the spark-plug hole open in the cylinder head. Well, he could have, but. . . ."

Jerry's face brightened.

"But it would have made enough noise to wake the dead, and oil would have spattered everything under the hood."

"He cleaned up afterwards," Jerry began.

"No," Gus cut in. "See this engine. It has regular layers of oil and dirt." He scraped through some of them with his pocketknife. "Just what you'd expect on a motor that's been run a lot. If Constantine had cleaned off the new oil, the engine would be a lot cleaner now—most of this old oil and dirt would have come off, too."

Jerry was crestfallen. "We're sunk," he said. "Constantine was telling the truth."

"I wouldn't be too sure about that," Gus grinned as he went back to the workbench. He got one of the dusty bulbs.

"This is an ordinary burned-out taillight bulb," he explained. "Watch what I do with it now."

He broke the bulb and picked all the glass

and cement from its socket, leaving a small brass cylinder. From a box he took a new 14-mm. spark plug, measured the threads, and cut the cylinder down to the exact length. Then he took the cylinder and the spark plug over to the car.

"Notice," he told Jerry, "that the bottom thread in the spark-plug hole wasn't ripped out when the rest were." He pushed the brass shell gently into the hole. "That bottom thread forms a shoulder that keeps the shell from slipping down into the cylinder." He pushed the spark plug a fraction of an inch into the shell, and then began to screw it slowly into place. "What's happening now," he said, "is that the spark plug is cutting its own threads in the brass, and the cylinder is expanding to accommodate them." Then he connected the plug, got into the car, and stepped on the starter. The engine took hold promptly and ran smoothly.

Gus switched off the ignition and got out. "That proves," he said, "that Constantine *could* have driven his car to Oxdallas's place last night. I fixed up a car that way a couple of years ago, and it ran O.K. for four days, until we got a new head."

"Say!" Jerry exploded. Then his face fell. "It proves Constantine *could* have driven his car last night—but it doesn't prove that he *did* drive it, or even that he knows the trick you pulled."

Gus took the piece of brass from the scrap box out of his pocket. "This is the socket of a taillight bulb that Constantine flattened out by stepping on it," he said. "He did just what I've done—provided a substitute for the threads in the spark-plug hole to hold the plug in place."

With the blade of his penknife and a stub of pencil he carefully worked the flattened brass back to its cylindrical form. Then he held it to the light and squinted through it. "Look, Jerry—you can see the threads that the spark plug cut."

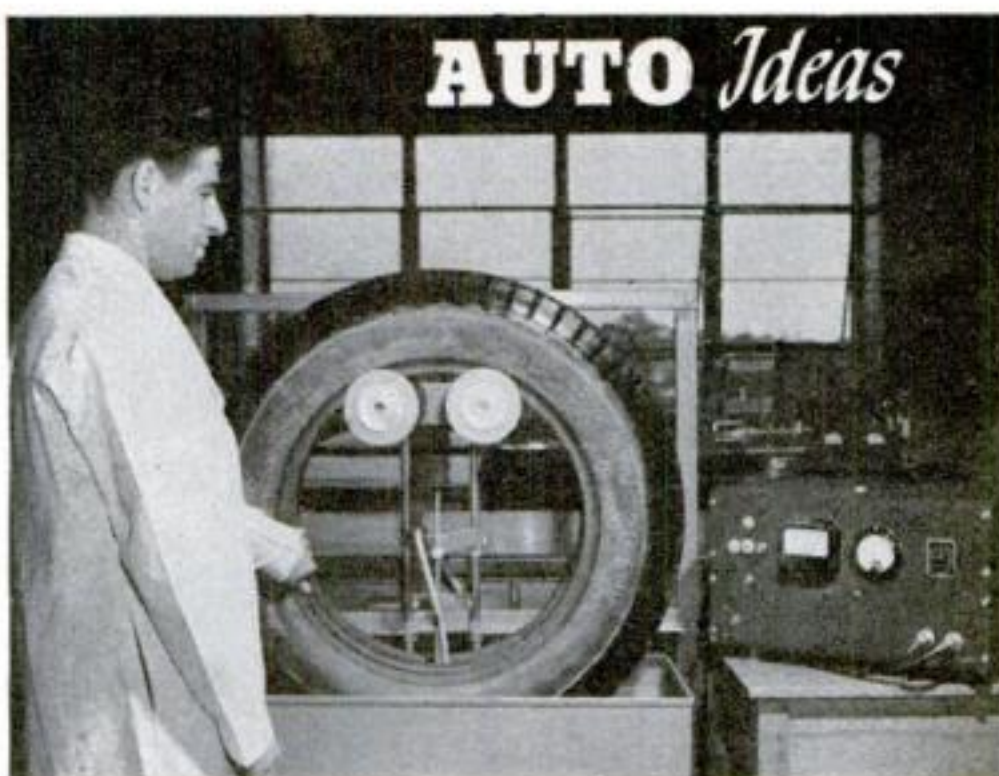
Jerry looked. "I guess," he said, "I'd better talk to the chief."

Late that night Gus's bedside telephone jangled. Jerry's voice on the wire was both tired and triumphant.

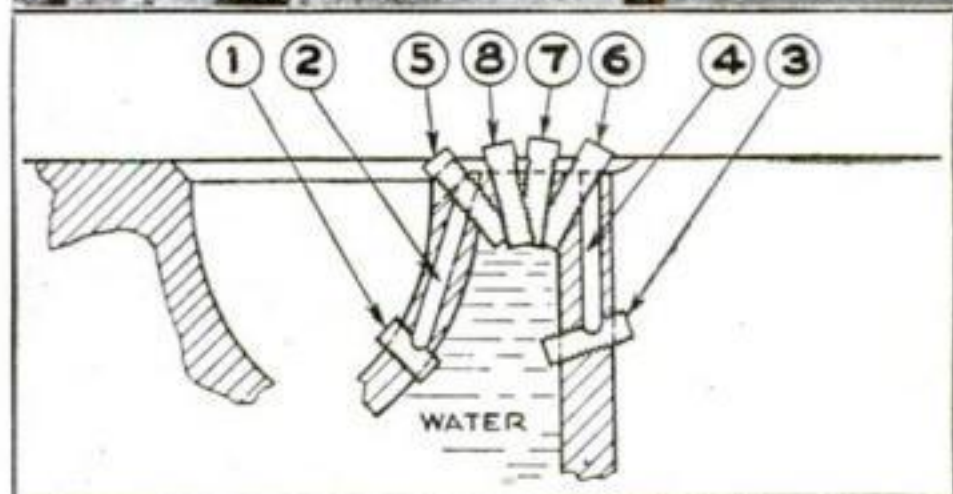
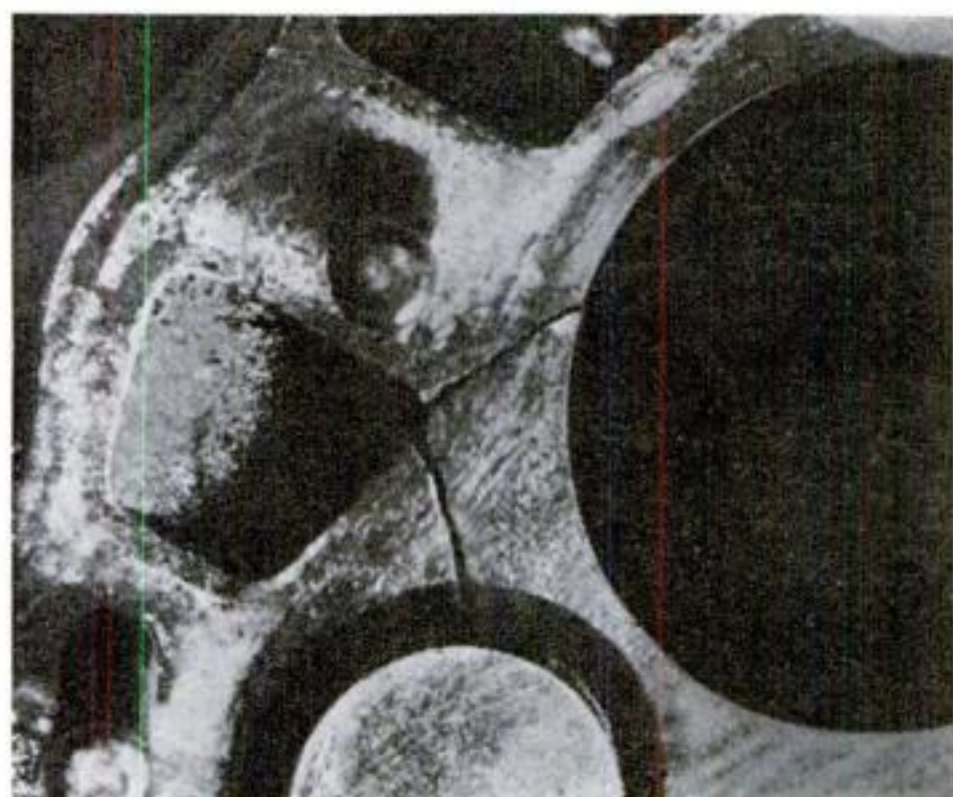
"It worked," he said. "When we took him down to his garage and showed him how you'd fixed his motor so it'd run, and then showed him your brass clue, he gave up and came clean. . . . Yes, confessed. . . . No, it was just plain robbery—he got over a thousand out of Oxdallas's cash box. . . . No, blowing the spark plug out of the cylinder head was accidental. It was after he'd fixed it so that he could use his car that he realized he had a good alibi if he needed it. . . . The chief is writing you a letter, Gus—I'd have it framed if I were you! Me? All I want is twelve hours' sleep!"

INVISIBLE BREAKS in tires offered for recapping or retreading are now spotted by supersonic vibrations—sound waves beyond the range of the human ear that are also used to record ocean depths and detect submarines. This adaptation, developed by scientists of the Goodyear Tire & Rubber Co., is especially useful in locating separations of the plies or layers of fabric composing a tire. It prevents wasting rubber on a defective tire.

The tire to be tested is demounted, suspended on rollers, and partially immersed in a tank of water. With a high-frequency current through a coil, supersonic vibrations are set up in a nickel rod extending into the tank. These waves, readily transmitted through water, are picked up by a microphone inside the tire. Vibrations pass through



solid portions with full intensity, but air bubbles in any breaks interrupt the waves, causing the microphone to flash a red light.



COLD WELDING, or "lacing," has found a place in war work, saving many a cracked motor block that in normal times would have been relegated to the scrap heap. The basis of the method is a new alloy of an extremely low coefficient of expansion and high heat conductivity, which tend to reduce expansion around the crack.

As described in a report prepared by the Society of Automotive Engineers for the Office of Defense Transportation, the crack is channeled and the ends drilled and tapped for pins of the new alloy, which are dipped in a liquid metallic sealing compound and inserted. Depending on the length of the crack, other holes are drilled and tapped at interlocking angles, and more alloy pins are inserted, "lacing" the crack together. The pins are peened and ground down to the original surface, making an almost invisible "weld." The motor block is then flushed with metallic seal and cleaned, and the job is finished. The photograph at left shows a crack at the valve seat of an L-head motor, and the diagram illustrates the method and order of inserting the lacing pins.

WARNING ON ANTIFREEZE made of calcium chloride solution or deodorized kerosene comes from the WPB and U. S. Bureau of Standards. Bureau engineers point out that the use of salt solutions is prohibited in Government vehicles. Salts corrode metal, especially aluminum. Bureau engineers know of no satisfactory corrosion inhibitor. Kerosene eats rubber hose and creates highly in-

flammable vapors. It can be detected by its oily feel and light weight, 6¼ to 7 lb. per gal., and salt solutions by their heavy weight, over 10½ lb. per gal. Boiling in an iron skillet—not aluminum—will give a whitish precipitate if salt is present, or a drop or two of silver nitrate added to two spoonfuls of antifreeze will precipitate any salt. Test or don't buy unknown brands.

HOME AND WORKSHOP



Ernest R. Dewalt has long been known to readers of Popular Science Monthly for the versatility of his craftwork projects. This month he offers the three-piece set of secretarial furniture shown above to fill a real need in the American home where the typewriter is used daily for study, household accounts, and correspondence

Personal Furniture..

FOR THE HOME SECRETARY

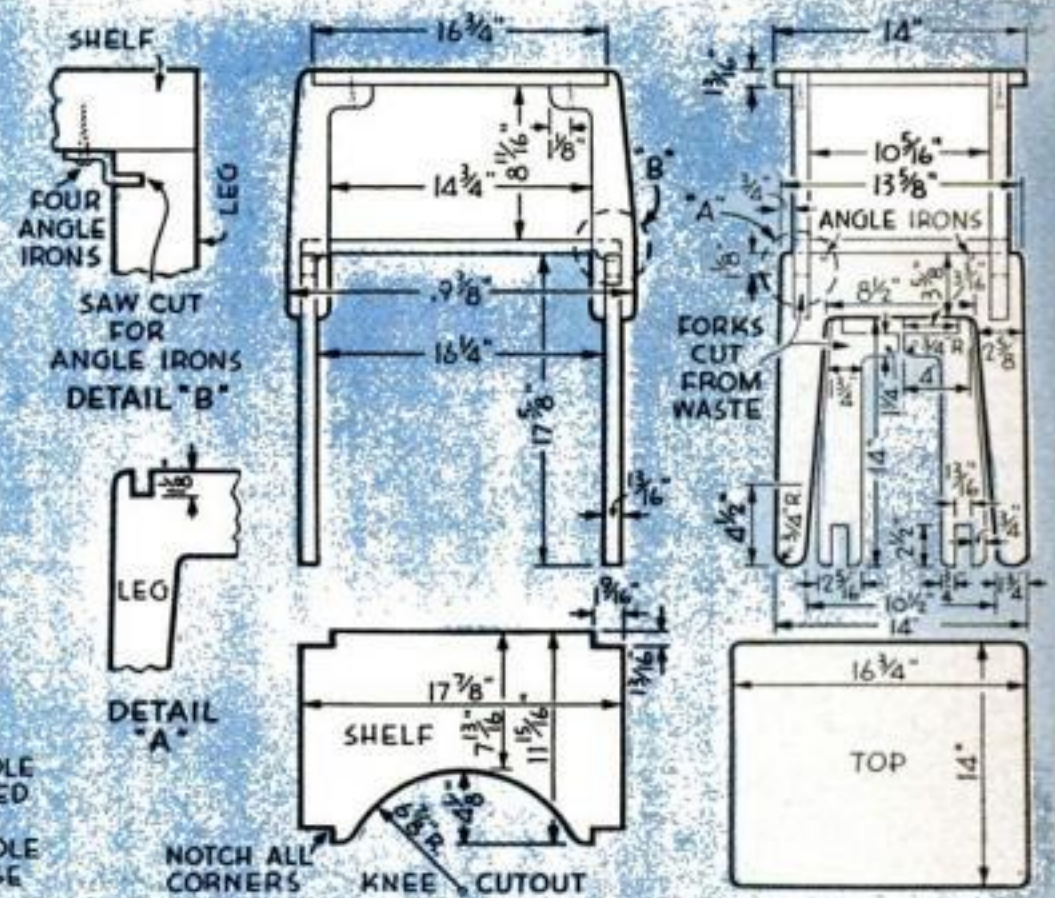
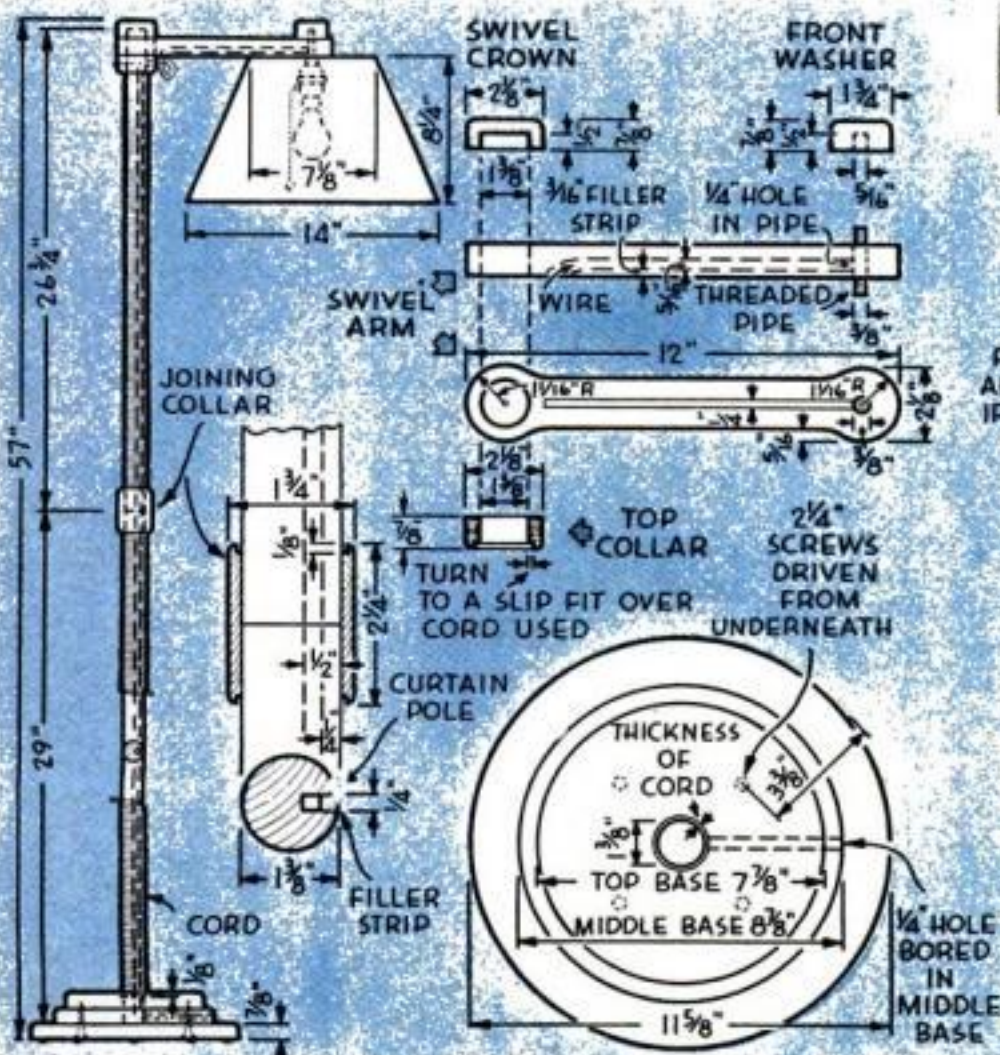
Chair, Typewriter Table, and Floor Lamp Are Ideal Projects to Make for the Den or Study

Designed by ERNEST R. DEWALT

MANY American homes have found the typewriter almost indispensable. The machine is used for correspondence, for writing out household accounts, and, by the younger generation, as an aid in the pursuit of schoolwork. To make it still handier, these three projects have been designed—a table of convenient height, a matching chair, and a lamp. They will go far toward simplifying work for the home secretary or student and, when not in use with the typewriter, will serve as occasional furniture.

All of the pieces are simply built, yet each presents interesting points of construction. Birch plywood $\frac{13}{16}$ " thick is used for both the table and chair. Sets of legs are made for the table in pairs. Lay out one pair of upper legs inside a pair of lower ones, attach

Turned at right angles to the lower table legs, matched upper legs make neat, invisible joints





Canvas stretched over dowels forms the seat of this convenient chair, which is sawed out from pieces of birch plywood

the two rear stretchers, as shown in the drawing, allowing space for the thickness of the canvas. Bolt the back to the upper dowel and screw it to the lower one, using washers to keep from twisting and tearing the canvas fabric. Small decorative buttons are turned and screwed to the ends of the stretchers.

The lamp standard is made of a 27" length and a 29" length of $1\frac{3}{8}$ " curtain pole. Rip out a $\frac{1}{4}$ " by $\frac{1}{2}$ " channel in each and glue in flush a $\frac{1}{4}$ " by $\frac{1}{4}$ " filler strip to make a longitudinal space for the wire. Each piece is then wound in the lathe with white cord, leaving a bare section at each end for fitting. A mahogany turning forms a collar joining the two, and three mahogany disks make the stepped base. Mahogany turnings also form a collar at the upper end and a swivel crown and washer for the lamp arm, as shown in the drawing. The arm itself is cut from mahogany and grooved and filled in for the wire like the standard.

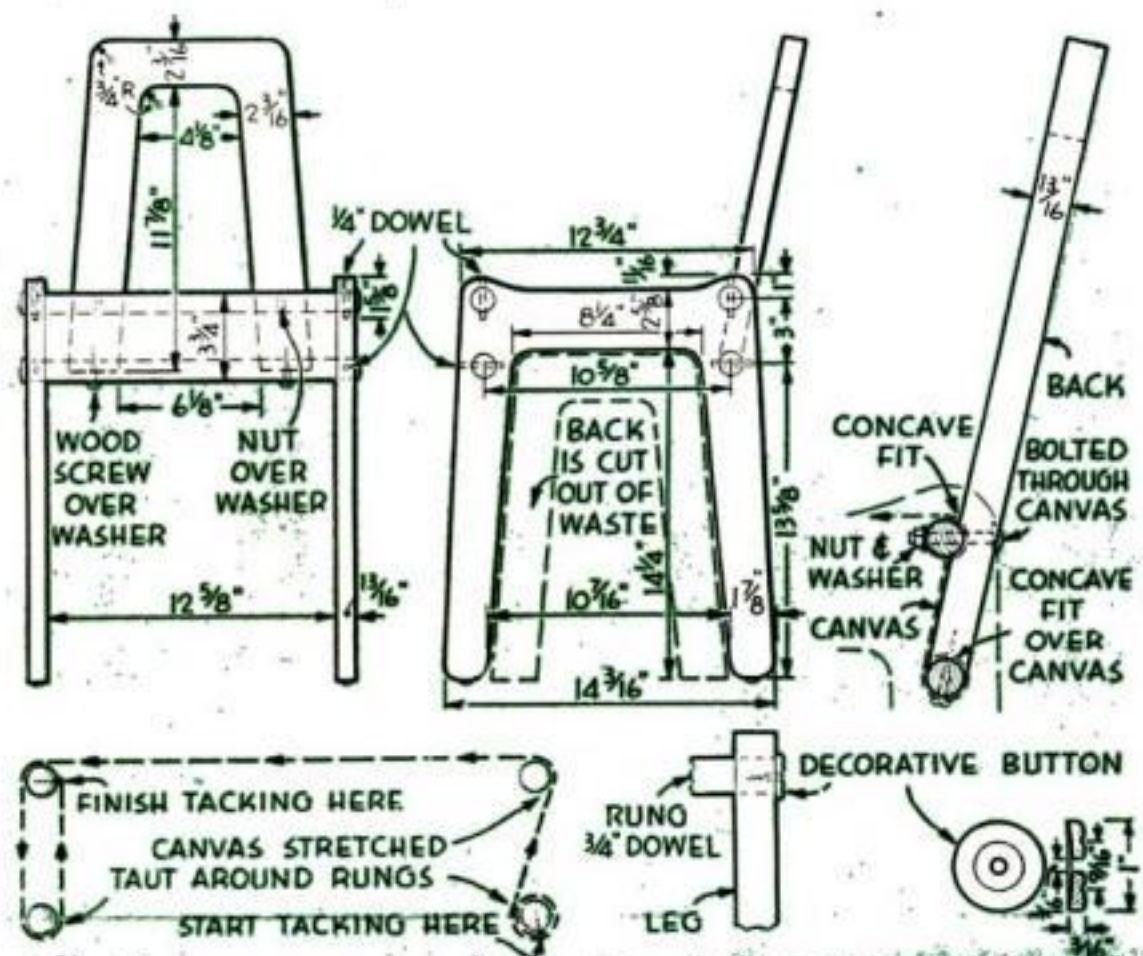
Finishing is similar for all pieces, two coats of clear varnish being applied to all exposed wood except the end grain of the table and chair,

a second piece of plywood with nails in what will be waste, and bandsaw them all at the same time. Make the long notches in the upper sets a snug fit for the stock used so that, when the piece is assembled, the glued joints will not show.

The chair legs are also made in pairs and band-sawed at one time, while the back is laid out and sawed from the waste inside one pair of legs. Hardwood dowels $\frac{3}{4}$ " in diameter are used for the double stretchers at front and back. A strip of olive-drab canvas, $12\frac{1}{4}$ " wide by 24" long, forms the seat. It is tacked first at the back of the lower rear stretcher; then it is wound completely around that dowel, up and over the top, and onto the lower front dowel where it is also tacked. Hold a padded iron against the dowels and space the tacks 1" apart.

Groove the back to fit

which may be painted to harmonize with the canvas chair seat. A shellac or varnish finish is also suitable for the corded sections of the lamp. Average working time: Table, 6 hours; chair, $6\frac{1}{2}$ hours; and lamp, $5\frac{1}{2}$ hours.



ORNATE OLD PICTURE FRAME FORMS QUAIN

Curio Cabinet

By JOSEPH ARONSON

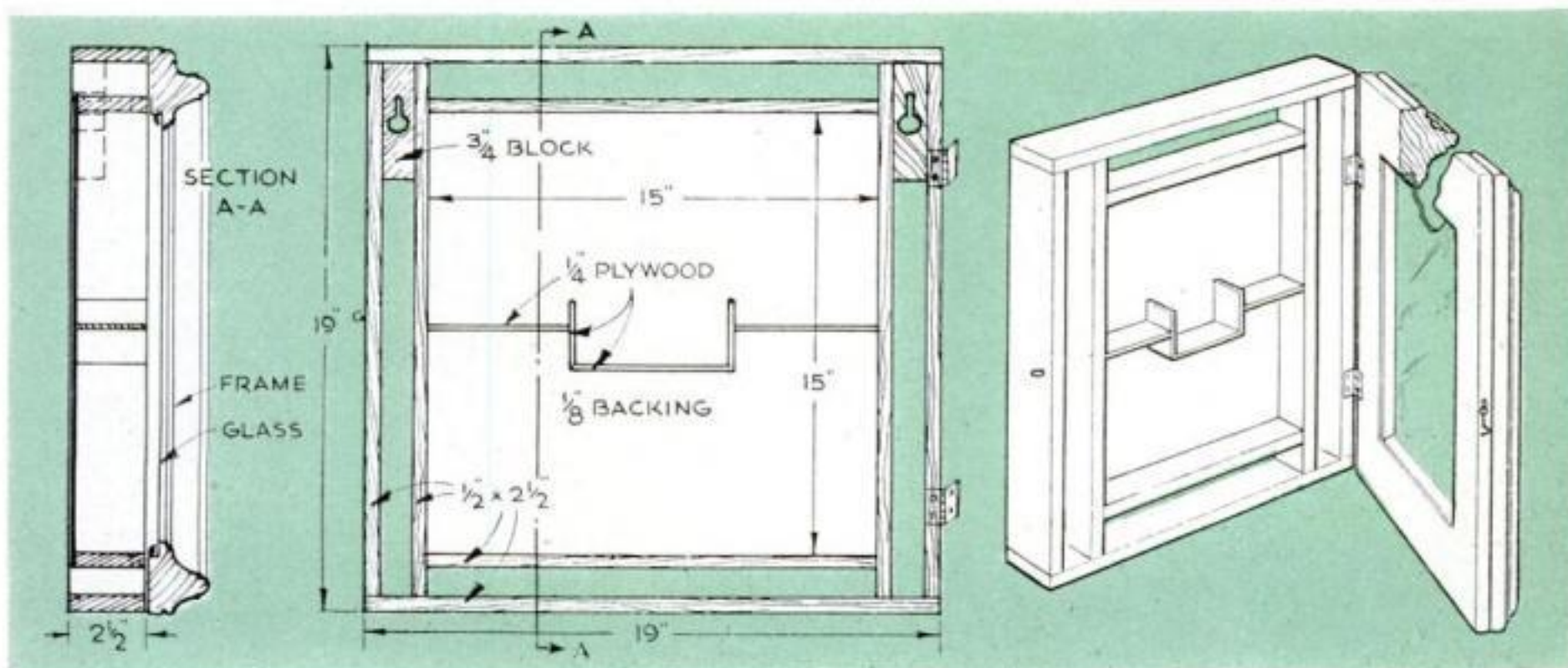
A SEARCH of almost any old attic will uncover interesting picture frames, too good to be thrown away yet too ornate for contemporary use with pictures. Many of these frames can easily be converted into attractive hanging cabinets for bric-a-brac or small antique articles of value. Such cabinets not only keep dust off the objects and thus display them to best advantage, but also protect valuable items against breakage.

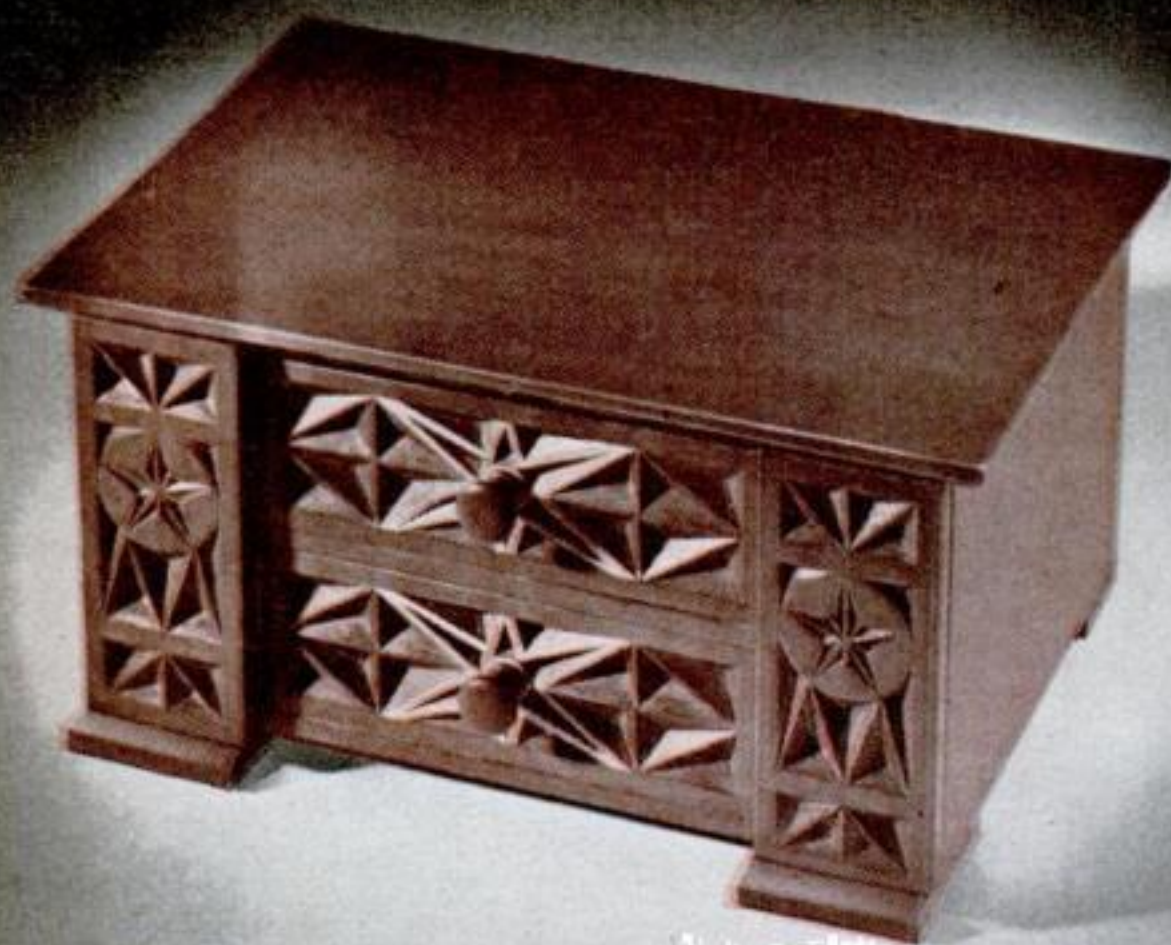
Plan the case to be exactly the same outside size as the picture frame. A depth of $2\frac{1}{2}$ " is about right to accommodate average-sized pieces, although it would be wise to measure those to be displayed in the case and to make the depth to suit them. The inner frame should be slightly larger than the opening of the picture frame. In the cabinet shown, the inner frame measured 15" by 15" for a picture-frame opening of 14" by 14".

All members were made of $\frac{1}{2}$ " pine except the interior shelves, which were of $\frac{1}{4}$ " ply-

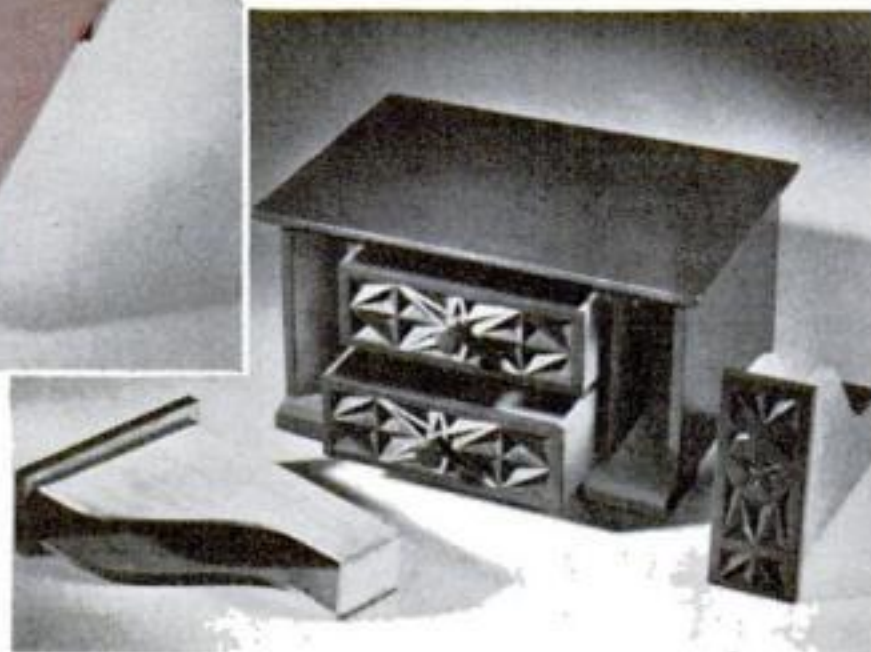
wood. Provision for hanging the cabinet was made by gluing in two blocks, as shown in the drawings, with holes and slots which fit over two long screws driven into the wall. The whole inner framework was made $\frac{1}{8}$ " less in depth than the outside frame, to allow a backing to be put in. This backing can either be covered with fabric or decorative paper to harmonize with your collection, or else painted in a suitable color. The picture frame is hinged to the inner frame and fastened with an ordinary hook.

The plywood shelves can be made to accommodate any particular group of articles to be displayed





Intricate designs on the drawer faces of this desk accessory are cut by chip carving. Below, the cabinet drawers are pulled out to display construction details



Simple Chip Carving Decorates This Attractive

Stationery Chest

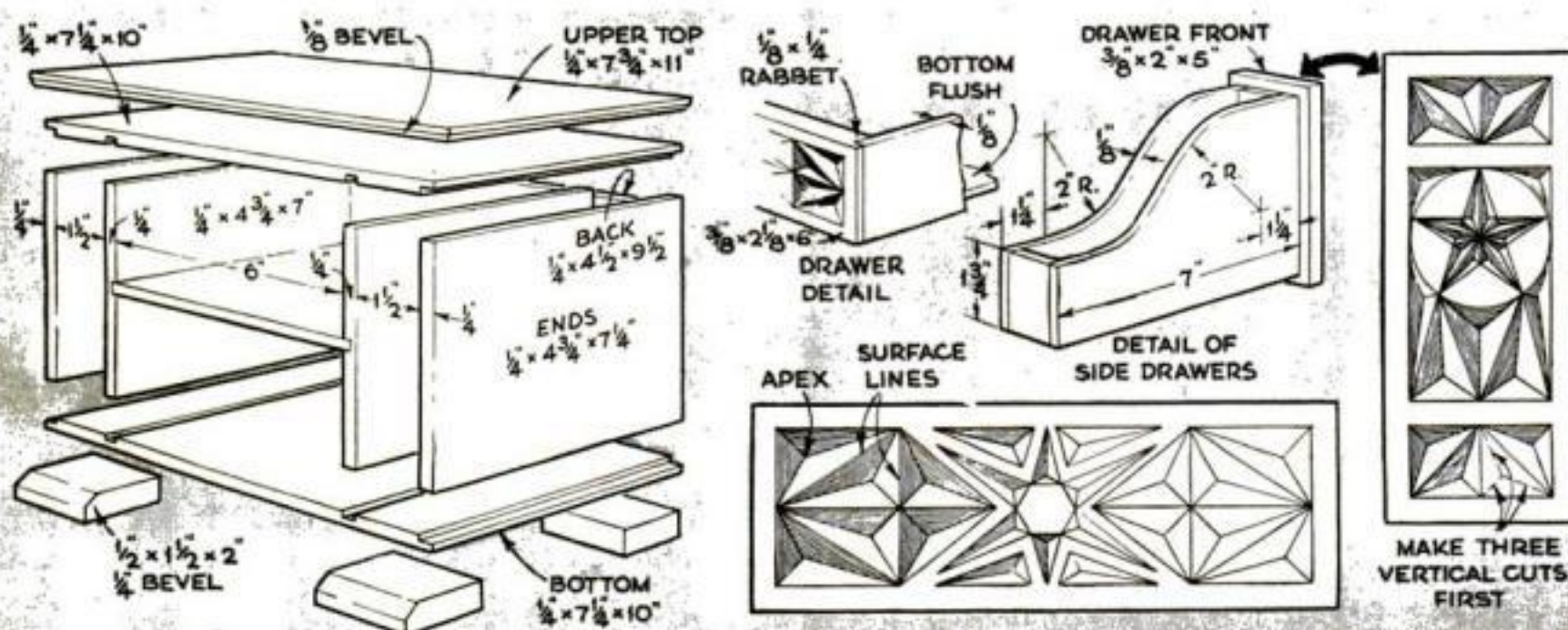
By ARNOLD C. WATSON

THE simple but effective decoration on this little desk chest was worked out by chip carving, which is actually a geometrical arrangement of triangular pyramids. This type of carving is easy to master; the project shown was the author's first attempt.

Use either a chip-carving knife or a $\frac{1}{2}$ " skew chisel. With the work flat, first make three cuts vertically downward from a point over what will be the apex of the inverted pyramid, tapering the depth of these cuts from the apex up to the corners of the

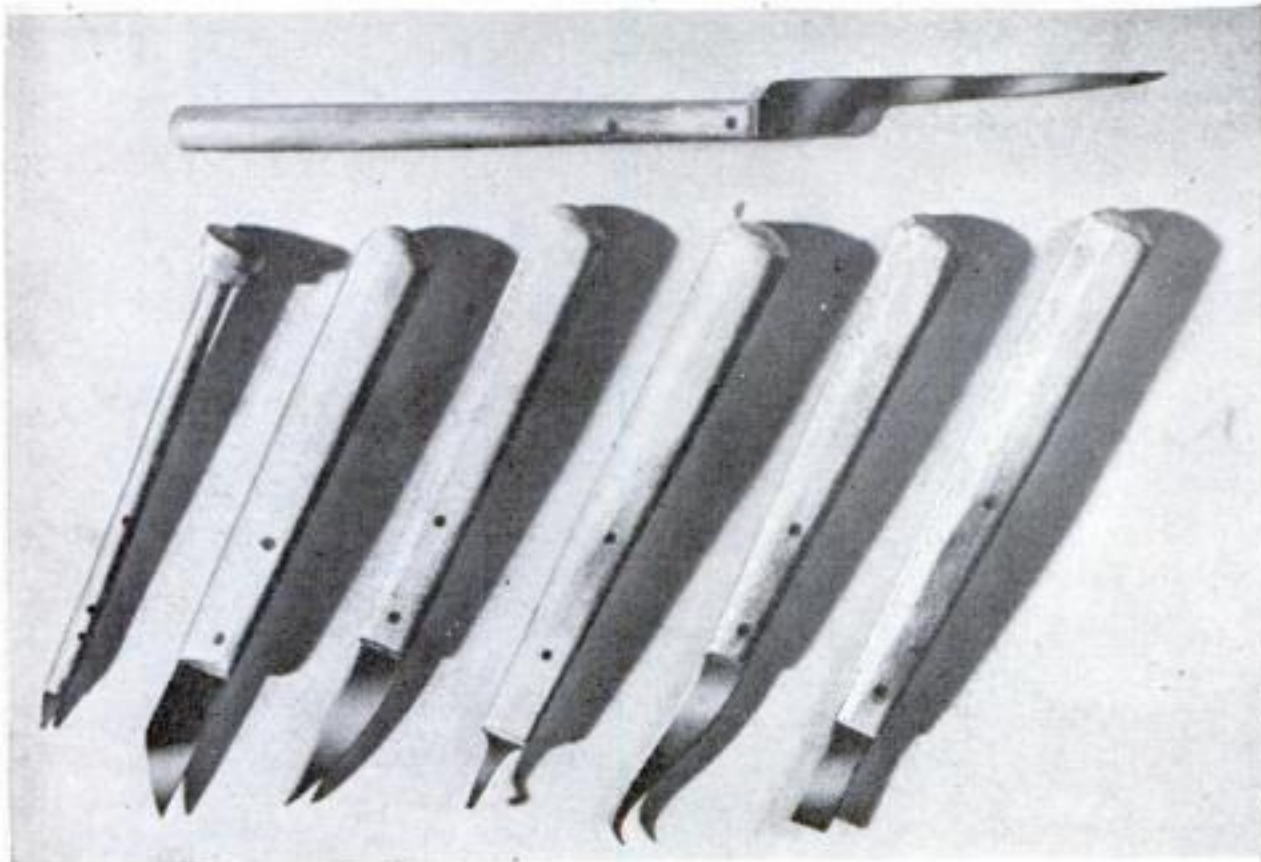
triangle. The next are shallow paring cuts at an angle from the sides of the triangle sloping toward the apex. Gradually cut out most of the chip and finish it with paper-thin strokes so as not to cut through wood or overrun the outline. The finished depth of the pyramid at the apex varies from $1/16''$ for the small cuts around the star to $1/4''$ for the largest cuts in the design shown. Keep the chisel well honed.

The chest is of $\frac{1}{4}$ " stock, but the drawer fronts of $\frac{3}{8}$ " stock to allow for carving. All rabbets and dados are $\frac{1}{8}$ " deep. Other dimensions are given in the drawing.



NEW TOOLS FROM OLD HACKSAW BLADES

By C. W. Bertsch



These unique tools, which are of special value to the model builder, can be made from sections of hacksaw blades. The high-quality steel holds a keen edge and will stand up well even under rigorous service

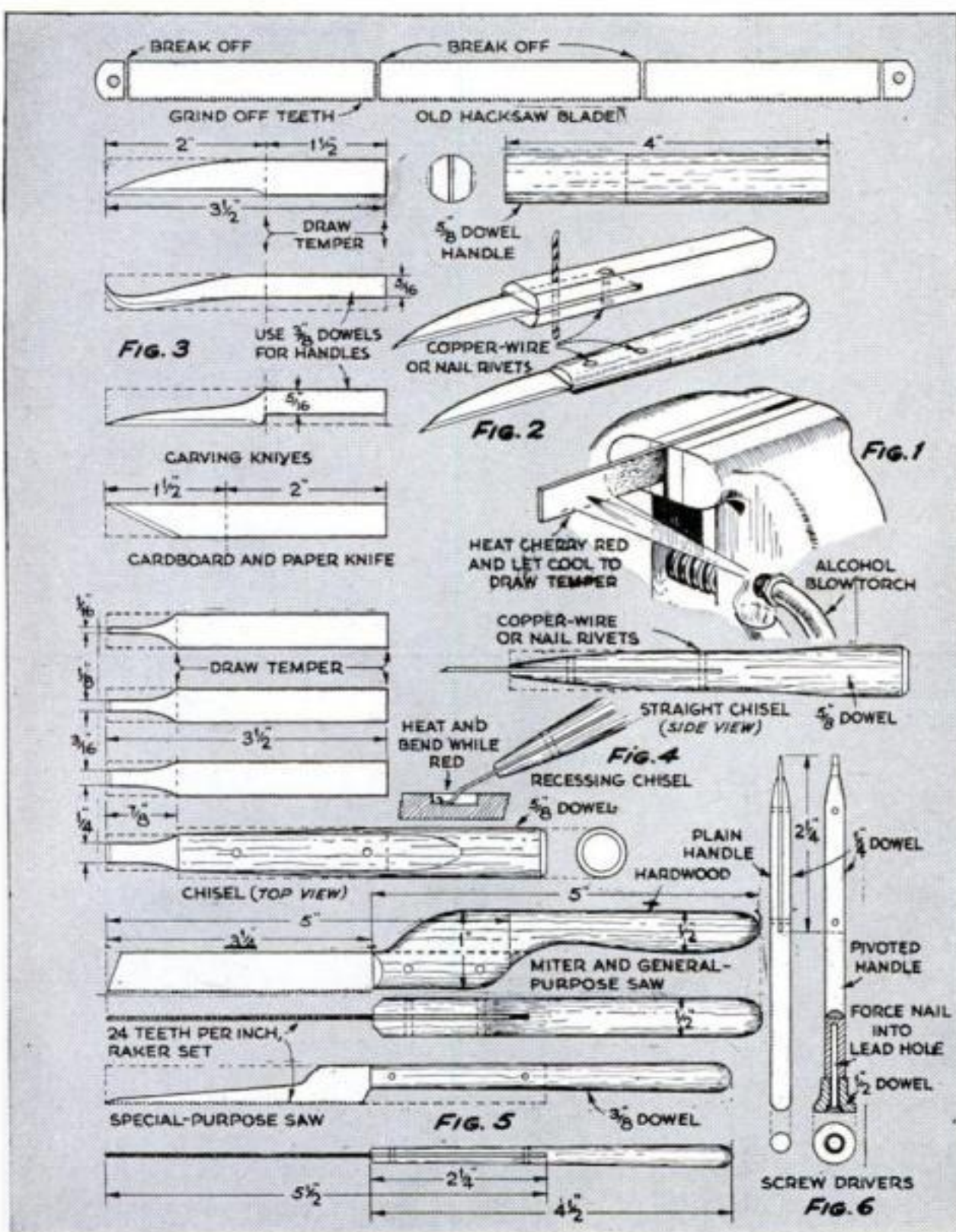
RAZOR-edged knives, chisels, and other tools may easily be made from worn or broken hacksaw blades. Designed to reach hard-to-get-at spots, these tools are particularly suited to model making or other fine work. Blades, nails or copper wire (No. 10 gauge or smaller), and short lengths of dowels are the only materials needed. A 12" blade is sufficient for three tools.

An all-hard blade, .025" thick, is best. Break off the required length in a vise and anneal the part to be inserted in the handle, so that it can be drilled. A small alcohol torch generates enough heat for this purpose. Place the part in a vise, heat to a dull red, and let cool (Fig. 1). The vise will prevent the heat from reaching the tempered end. Grind the blade to shape, taking care not to draw the temper by "burning"; then grind the edge.

A dowel serves for the handle. Cut a slot for the blade and drill two holes just large enough for the wires or nails to fit tightly (Fig. 2). Use a small ball-peen hammer to form the rivets. Shape and smooth the handle on a sander or with a file, and put a keen edge on the blade with an oilstone. This knife will hold its edge through hard service.

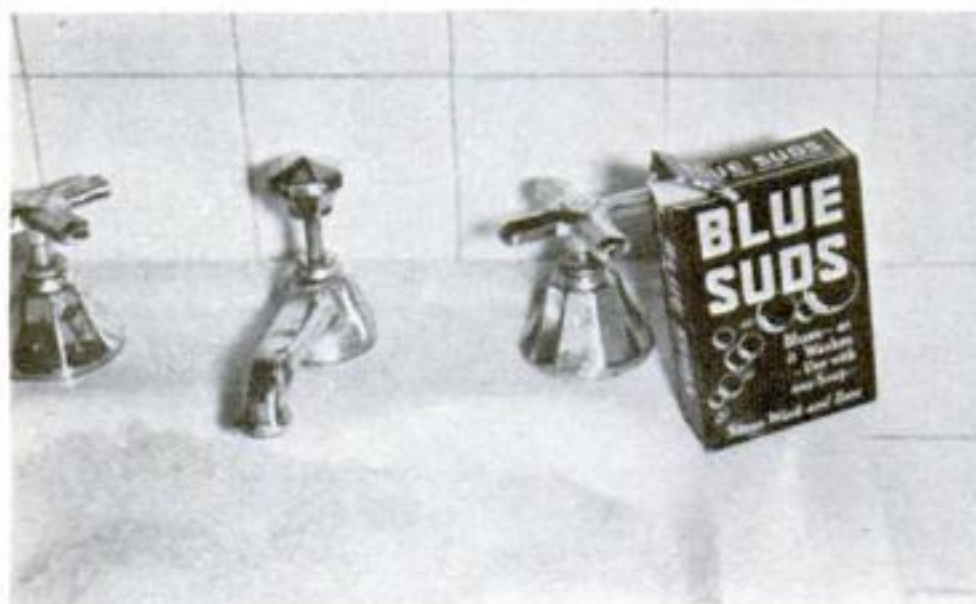
Illustrated in Fig. 3 are other blade shapes. Excellent chisels for delicate work can also be made in the same manner. To retemper the recessing chisel (Fig. 4), heat it to a cherry red and plunge it into water.

The saws in Fig. 5 should, of course, be made from a new blade. Small screwdrivers, with either plain or jeweler's pivoted handles (Fig. 6), may also prove to be useful additions to your kit of special tools.



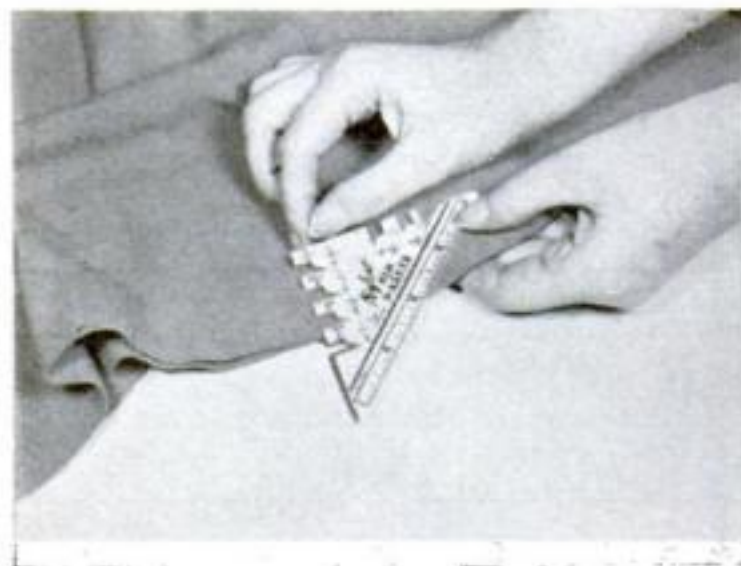


CLOTHES HANGERS are now being made entirely of wood. They have two-part wooden hooks designed to give correct balance when in use. Both inner edges of the hooks are rounded out to fit securely on the closet hanging bar



BLUE SOAP FLAKES help reduce time required to wash clothes because the bluing is used in combination with soap chips or flakes during the washing operation. The bluing flakes are packaged in a carton similar in shape to those containing regular soap flakes, but about one third the size. Being concentrated, fewer flakes are used

PLASTIC COMES TO AID the seamstress in the form of a triangular scale having a 4" rule on one of its sides and indentations on the other two sides. The notches are in $\frac{1}{4}$ ", $\frac{1}{8}$ ", and $\frac{3}{8}$ " graduations. The hem marker is simple to use as the notches make it possible either to put pins in the fabric or to mark the hem edge with tailor's chalk



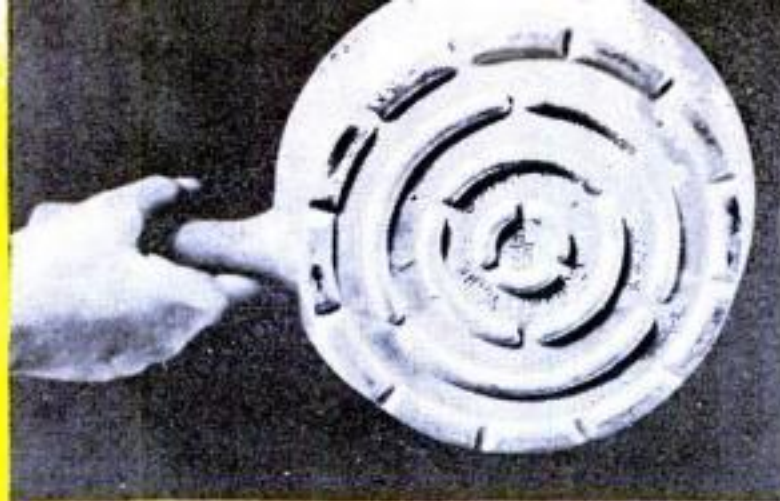
AIDS TO WARTIME *Housekeeping*



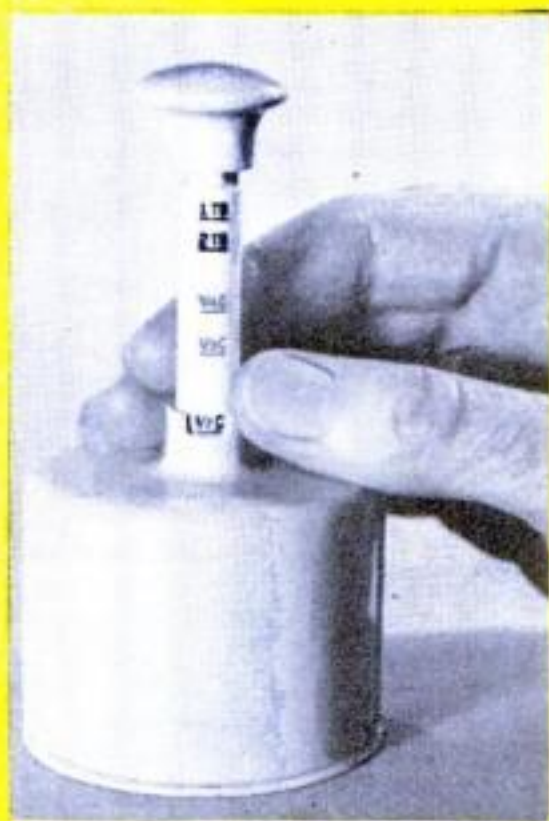
A **NEW BUTTON KIT** is now added to the list of housekeeping aids. It contains an assortment of 100 buttons of popular colors and sizes particularly suitable for use on men's and children's clothes. The kit is partitioned to separate the various sizes of buttons, and the inside of the cover has an illustrated chart to aid in the selection of just the button you need. Included with the kit is an interesting booklet entitled, "Buttons—Tremendous Trifles," which tells the story of button making and gives helpful tips



LONGER STOCKING WEAR is said to be the result of using a new coating compound in stick form to prevent any chafing of the fabric. Applied as shown above, it may be used to coat the stocking surface where it rubs against a shoe. The stick is merely rubbed on the heel and toe of the stockings after they are put on. Ordinary laundering washes out the special coating without harm



CERAMIC COOKING UTENSILS now being shown are made with grooved bottoms that expose a greater area to the flame of a stove, causing the inside surface to heat more quickly and more evenly. The items include frying pans, pots, and ramekins for service at the table as well as for cooking. All interior surfaces of these nonporous utensils are glazed to prevent absorption of flavors and to guard against oxidation and other chemical changes that sometimes occur with metal. Exteriors are natural clay, the interiors French brown



• • •
THIS HANDY CUP will help make measuring of shortening accurate and fast. The plunger is marked off in graduations ranging from one tablespoonful to a half cup. It is set at a desired amount and the cup is filled level with the bottom edge. Pushing the plunger empties the cup. The measuring device is entirely of plastic
 • • •



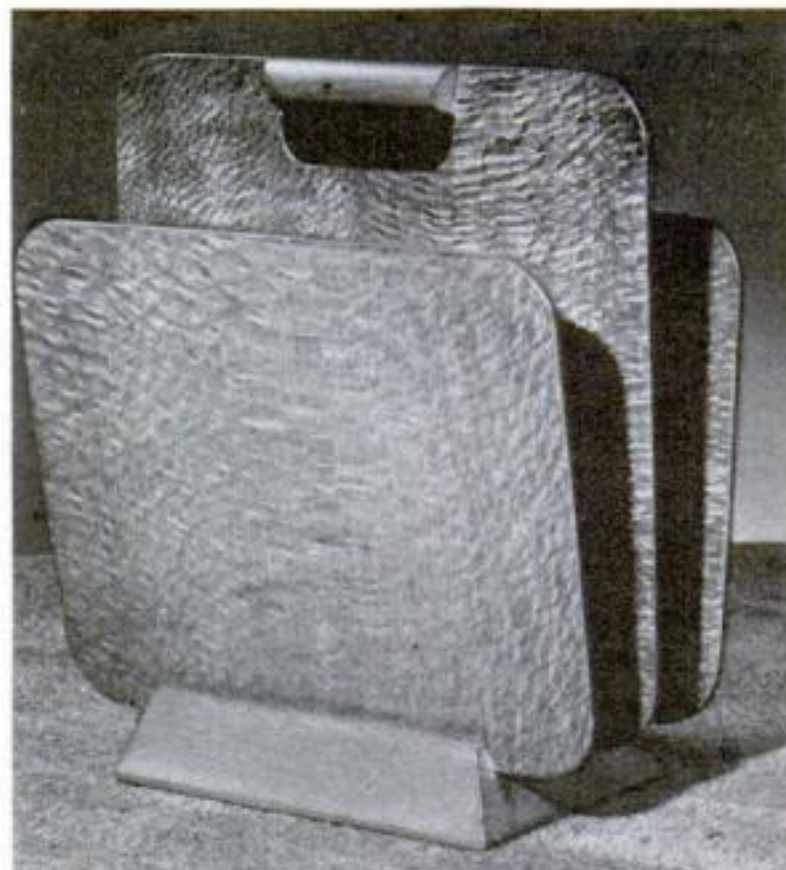
A NEW MAGIC LIQUID is being used to mend holes in cloth goods caused by burns, moths, or accidental tears. First the frayed edges are cut away, a patch is cut to fit, and the liquid spread over the patch and the edges of the hole. Then a piece of lining is placed behind the area, pressed down, and set aside to dry. The liquid also stops stocking runs



PLASTIC FLASHLIGHT CASES are now being made to withstand hard use in emergency situations of cold and heat from 40 deg. below zero to 175 deg. above. The one illustrated has two cells, is prefocused, and has, in addition to its positive "on" and "off" positions, a midway setting that permits operation of the button for fast or slow flashing. An extra emergency bulb is in the bottom cup. Since its case is waterproof, the flashlight will operate under water. It has a hook for fastening to a person's belt or hanging to a projection



Natural wood grain adds to the beauty of these two magazine racks. However, the finish chosen should be one which will harmonize with your entire room



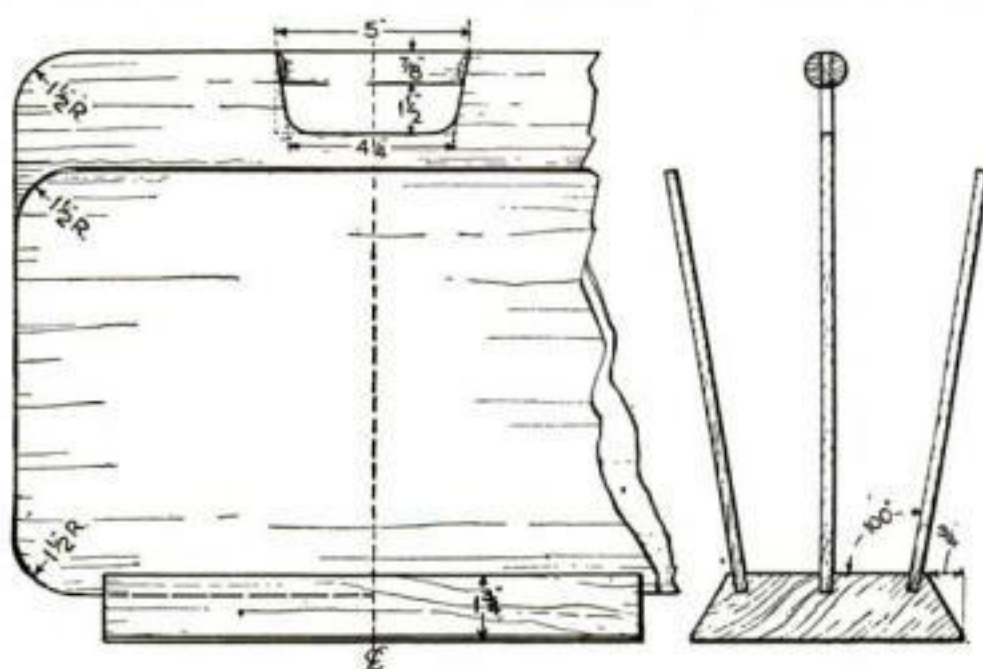
Magazine Rack Modern Design

By JOSEPH ARONSON

THE problem of where to keep current newspapers and magazines is solved with an attractive rack made of odds and ends. You can modify the proportions somewhat to suit the materials on hand if you have any plywood remnants, but the dimensions listed produce two well-proportioned pieces of furniture.

Both the racks shown were made of $\frac{1}{4}$ " birch plywood. Three panels were glued into slots in each base block. The center slot was cut at right angles and the two outer ones at 100 deg. to the base, all being a tight fit for the panels.

A hole cut in the center panel and trimmed at the upper edge with half-round molding forms a convenient grip. For embellishment, you can wrap leather, cane, or colored twine around the handle. If you find that the wood used has a pleasing grain, an attractive finish can be



List of Materials

LARGE RACK

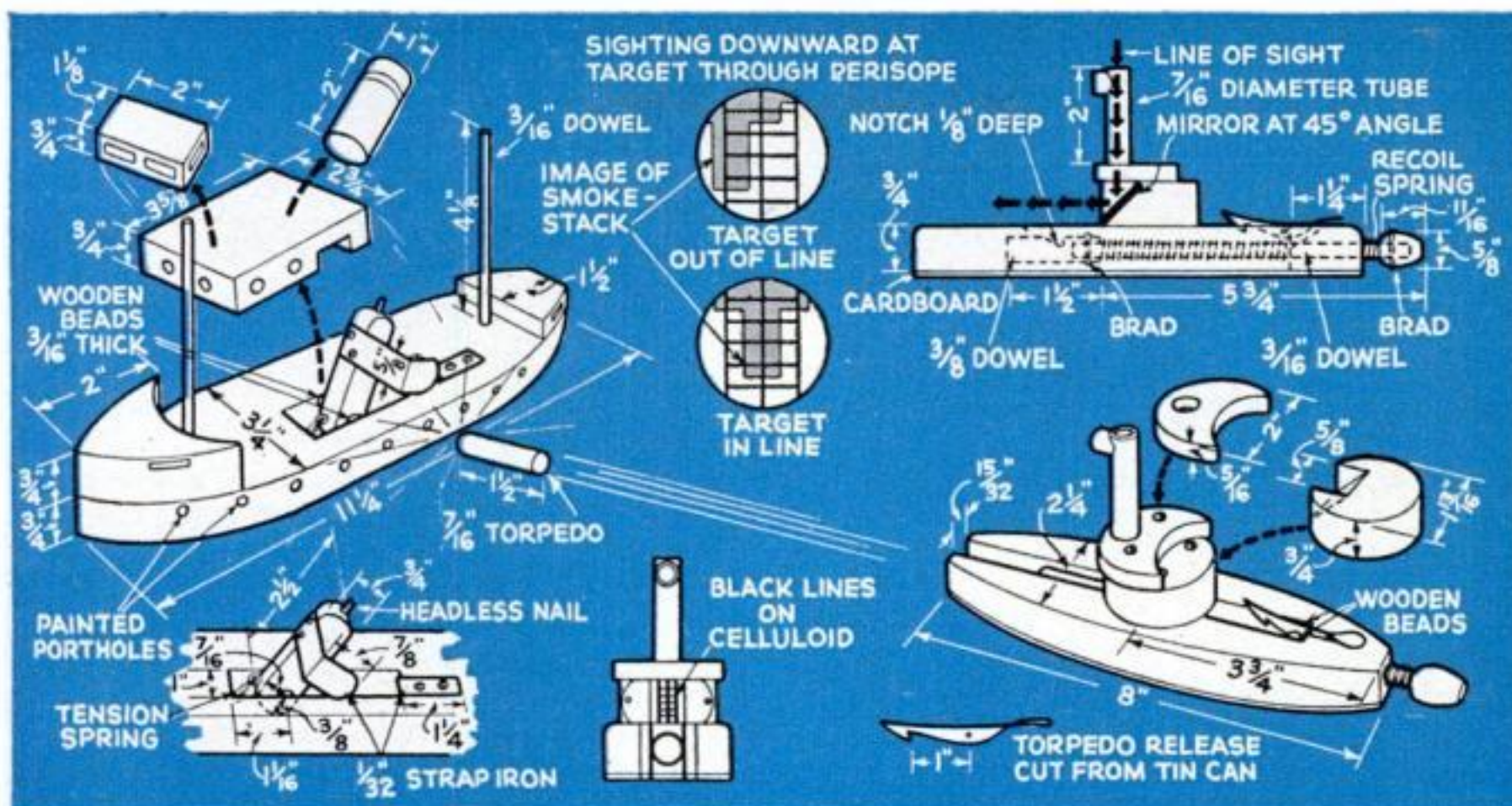
No. PC.	DESCRIPTION	T.	W.	L.
1	CENTER PANEL	$\frac{1}{4}$	14	18
2	SIDE PANELS	$\frac{1}{4}$	11	18
1	BASE	$1\frac{3}{4}$	7	14
2	HANDLE PIECES	$\frac{1}{2}$	$\frac{7}{8}$	5

SMALL RACK

No. PC.	DESCRIPTION	T.	W.	L.
1	CENTER PANEL	$\frac{1}{4}$	14	14
2	SIDE PANELS	$\frac{1}{4}$	11	14
1	BASE	$1\frac{3}{4}$	7	10
2	HANDLE PIECES	$\frac{1}{2}$	$\frac{7}{8}$	5

NOTE: ALL DIMENSIONS ARE GIVEN IN INCHES

secured by applying a few thin coats of shellac, being careful to sand well between each coat. Rub the last coat with a hard wax to achieve the final finish.



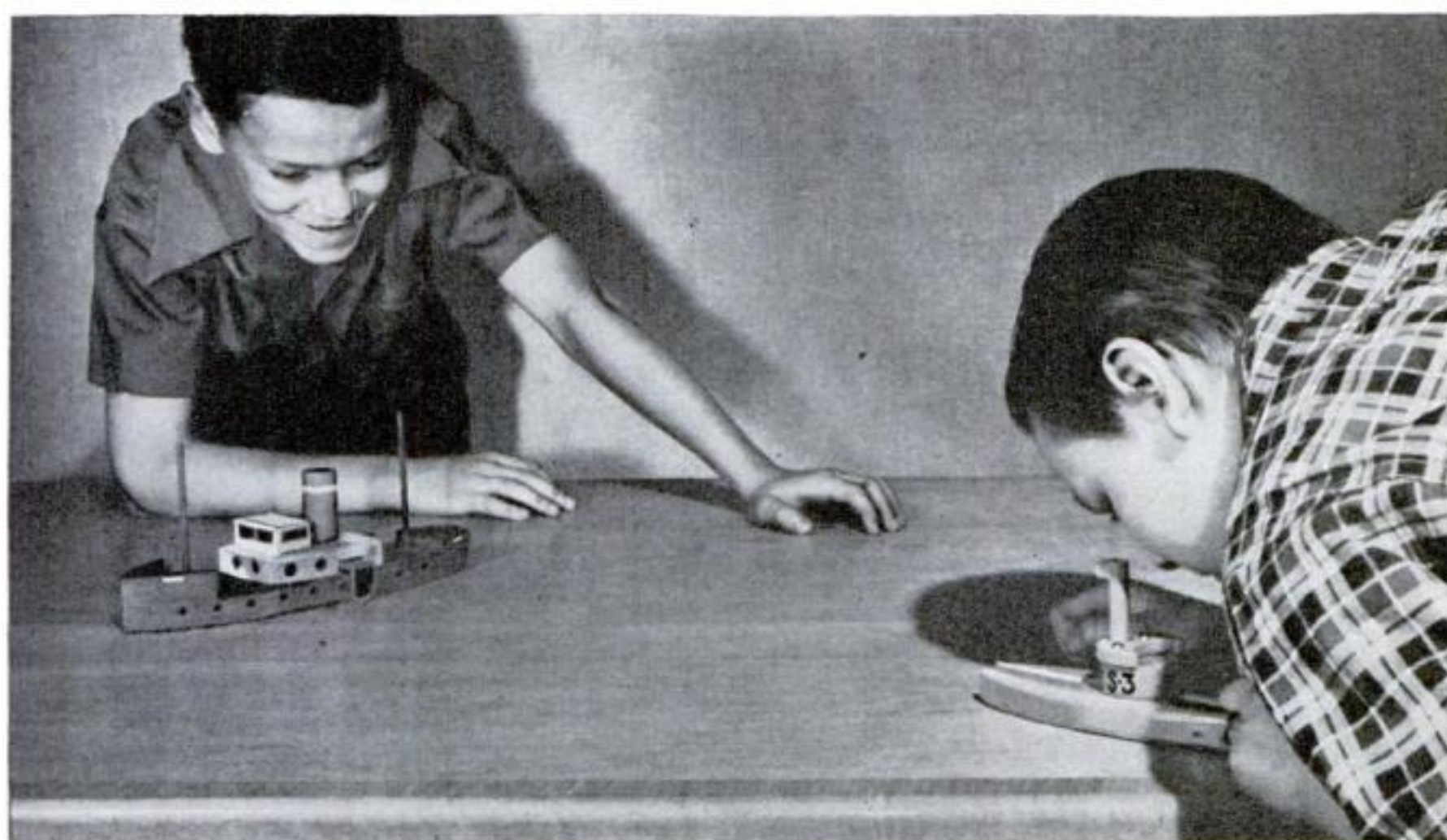
Sub with Periscope Sight "Explodes" Ship

AIM through the periscope sight of this submarine, fire a torpedo, and watch the doomed enemy freighter explode!

The torpedo tube is a slot $15/32$ " wide, running from the bow to within $1 1/4$ " of the stern of the submarine. A hole large enough to take a $3/16$ " dowel loosely is drilled through the stern. Assemble the torpedo-firing mechanism from a $3/16$ " dowel, a $3/8$ " dowel for the torpedo ram, and a cocking knob. The torpedo-release catch pivots on a nail driven across the slot, with two wooden beads for side bearings. Cement a mirror

$9/16$ " square in a slot cut at a 45-deg. angle in the conning-tower base; cover this with a celluloid window marked as shown.

Make the freighter's superstructure from a frame of $1/4$ " strips with a cardboard top. Use a 2" section of broomstick for the funnel. The exploding mechanism is a wooden bar, loosely pivoted on a nail and operated by a tension spring. A headless nail holds the bar under a projecting strip of metal. A second strip extends from the bar down the port side, where it constitutes a target for the torpedo.—MYRON FLEISHMAN.



SHOOTING INSECT LIFE WITH YOUR CAMERA

ONE of the least explored fields of photography lies within a few yards of the spot where you read these lines. Whether you live in town or country, in the mountains or by the sea, insects can always be found; and most of them furnish unrealized opportunities for taking striking and distinctive photographs.

During these late-summer days the insect parade is at its peak. Subjects for your lens are everywhere if you make your backyard a studio.

The two chief requisites of any good insect picture are: first, it must record the insect large enough to show detail; and second, the subject must be in perfect focus. Consequently the camera you use for insect photography must be capable of taking close close-ups, and it must have some method of insuring a perfectly sharp image.

My own preference is a 3¼" by 4¼" film-pack camera equipped with a ground-glass back and a double-extension bellows. Such a camera permits accurate focusing and, when its 15-cm. Tessar lens is replaced with a lens having a 1" focal length, magnifica-

tions up to a dozen diameters are possible.

For your initial shots, the larger insects, such as butterflies, moths, katydids, and praying mantes, offer the best chances for success. They are more likely to stay motionless while their pictures are being taken. Slow-moving creatures like walking sticks also co-operate well. Butterflies and moths make passive and unblemished subjects while their wings are drying just after they have emerged from their cocoons. By collecting cocoons during the winter, a supply of large, beautifully patterned moths, such as the Luna, Polyphemus, and Cecropia, can be provided for spring camera work.

Most insects, however, are lively creatures, and inducing them to pose is an important part of insect photography. A few amateurs stalk their quarry, edging close when the specimen alights. Coupled range finders are needed for this. However, one enthusiast has a slender rod fitted to his camera and, focusing for the length of the rod, snaps the shutter when the tip is even with the foliage on which an insect rests.

Simpler, and still more effective, is to



Photography

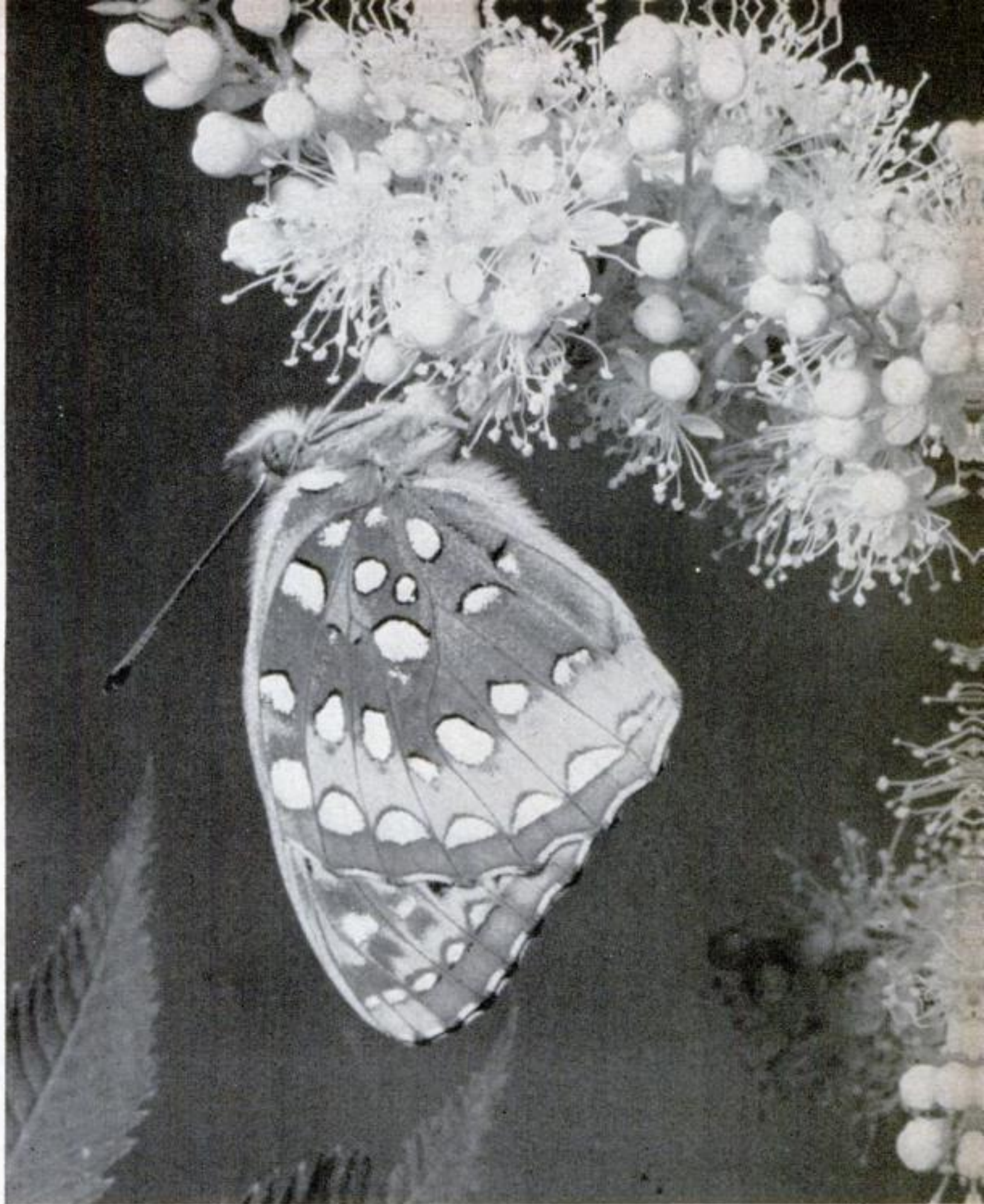
Portrait of a cicada—a 16-second exposure with a 1" focal-length lens stopped at f/16 and two photofloods. White cardboard behind the damselfly reflected light for the silhouette, made in 1 second with a Tessar 15-cm. lens stopped at f/32



By
EDWIN
WAY
TEALE

Just after emerging from its chrysalis, this great spangled fritillary butterfly poses on a sprig of spiraea. This is a 1/5-second exposure with a Tessar lens stopped at f/32 and two photofloods to provide the lighting

Awaiting prey, an ambush bug clings to buddleia for a 16-second exposure (lower left). A 1" focal-length lens at f/16 was used with photofloods. At right, below, a 1/10-second shot in brilliant sunshine of a short-horned grasshopper with a Tessar lens at f/32



focus on a plant, either outdoors or on a table indoors, and then place a captured butterfly or other insect in a natural and effective position on the foliage. Inasmuch as the section of the plant on which the insect clings is already in focus, the picture can be snapped the moment the insect is at rest. For close close-ups, focusing must be done on the insect itself.

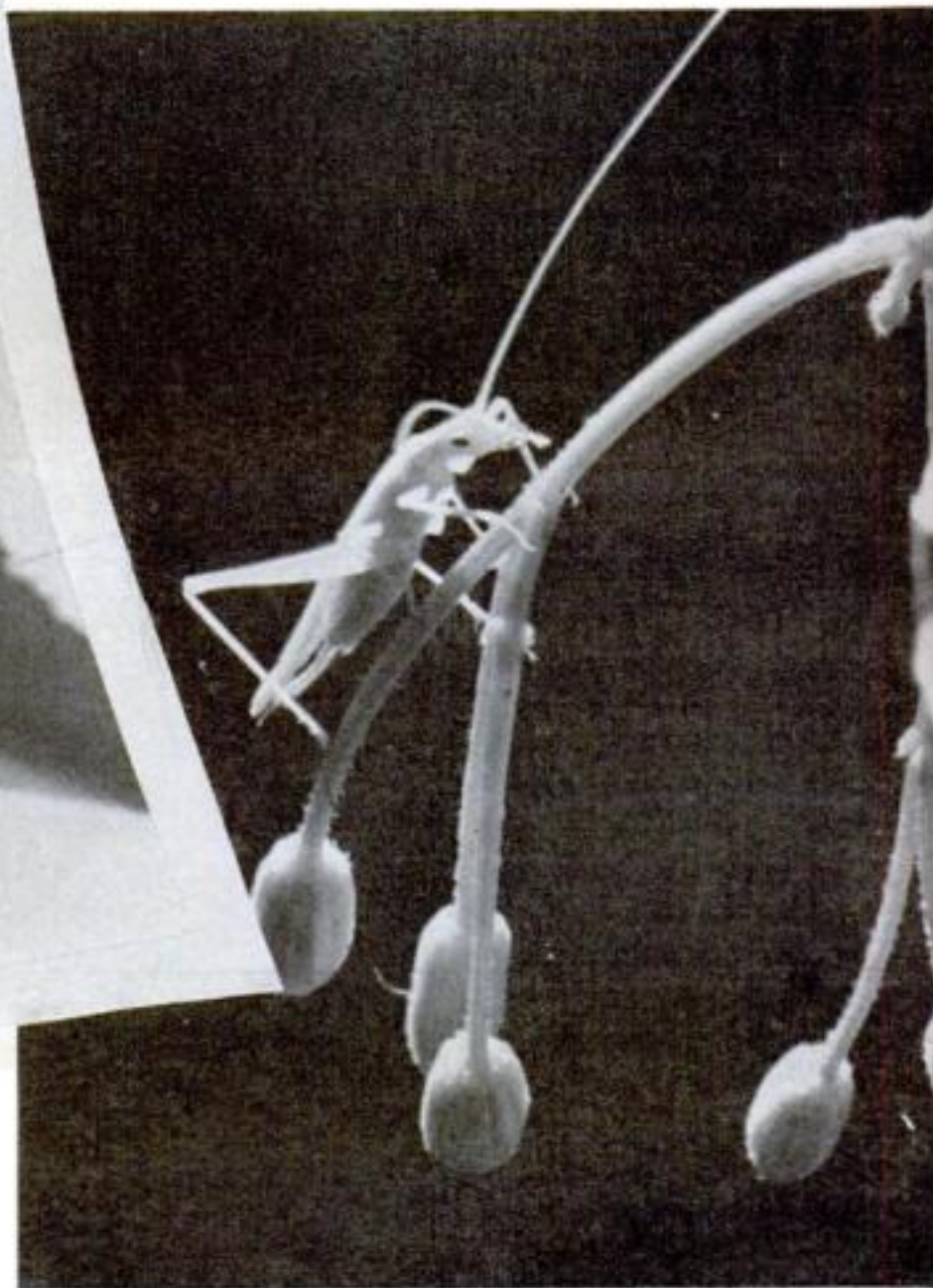
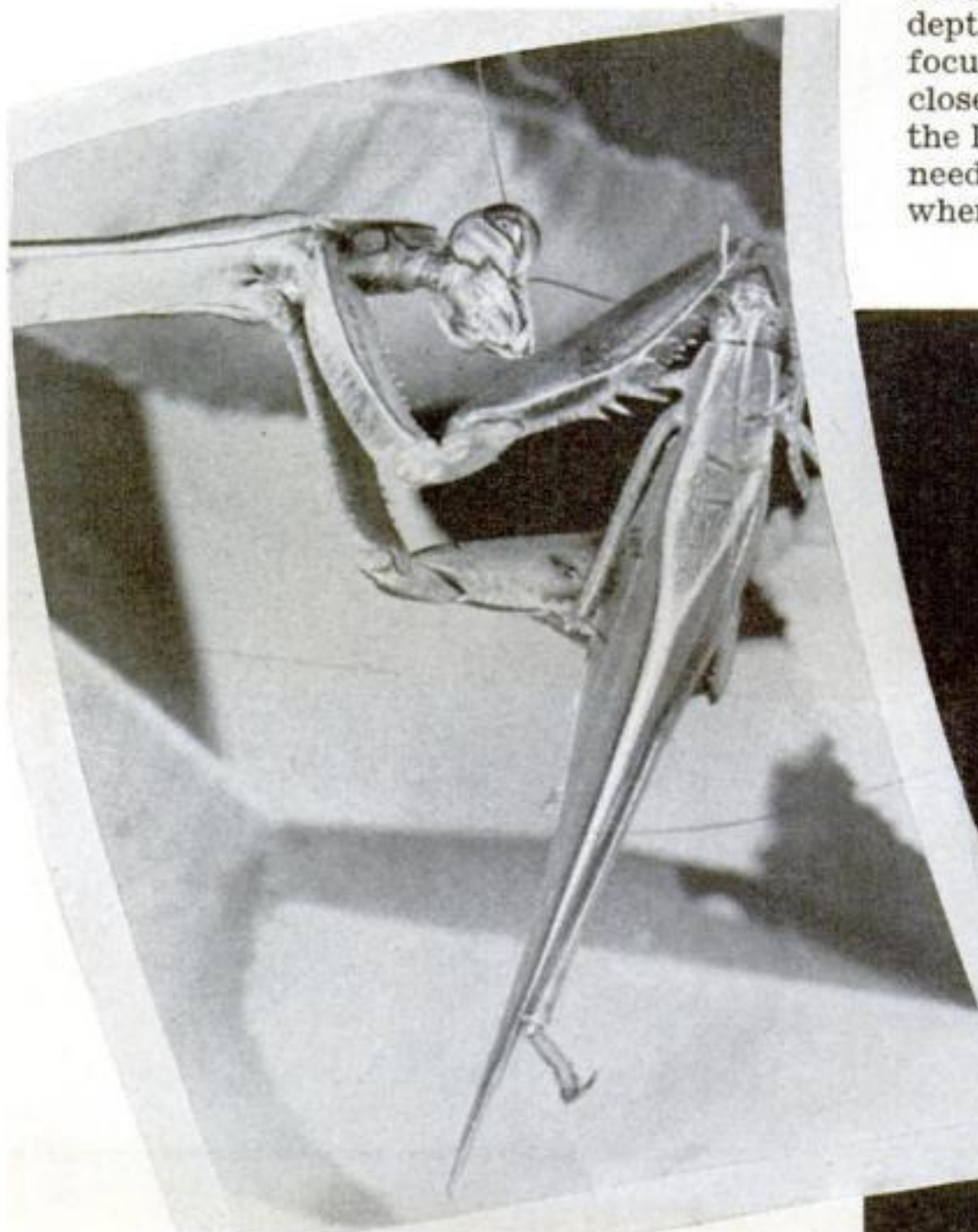
To reduce the natural liveliness of your subjects, you can employ any one of several methods. For instance, you can place a captured insect in a jar containing a wad of cotton batting soaked in ammonia. The fumes dull its senses and it clings more or less motionless when placed on a leaf or twig. Ether can also be used. The difficulty with such methods is that the insect may become so deadened it loses its life-like appearance.

By taking advantage of the nature and habits of different insect subjects, it is possible to catch them during their periods of

quiet. Butterflies are active during daylight and inactive at night, and moths, as a rule, follow the reverse procedure. So by taking butterfly pictures after twilight and moth pictures at midday, you find your subjects most quiet.

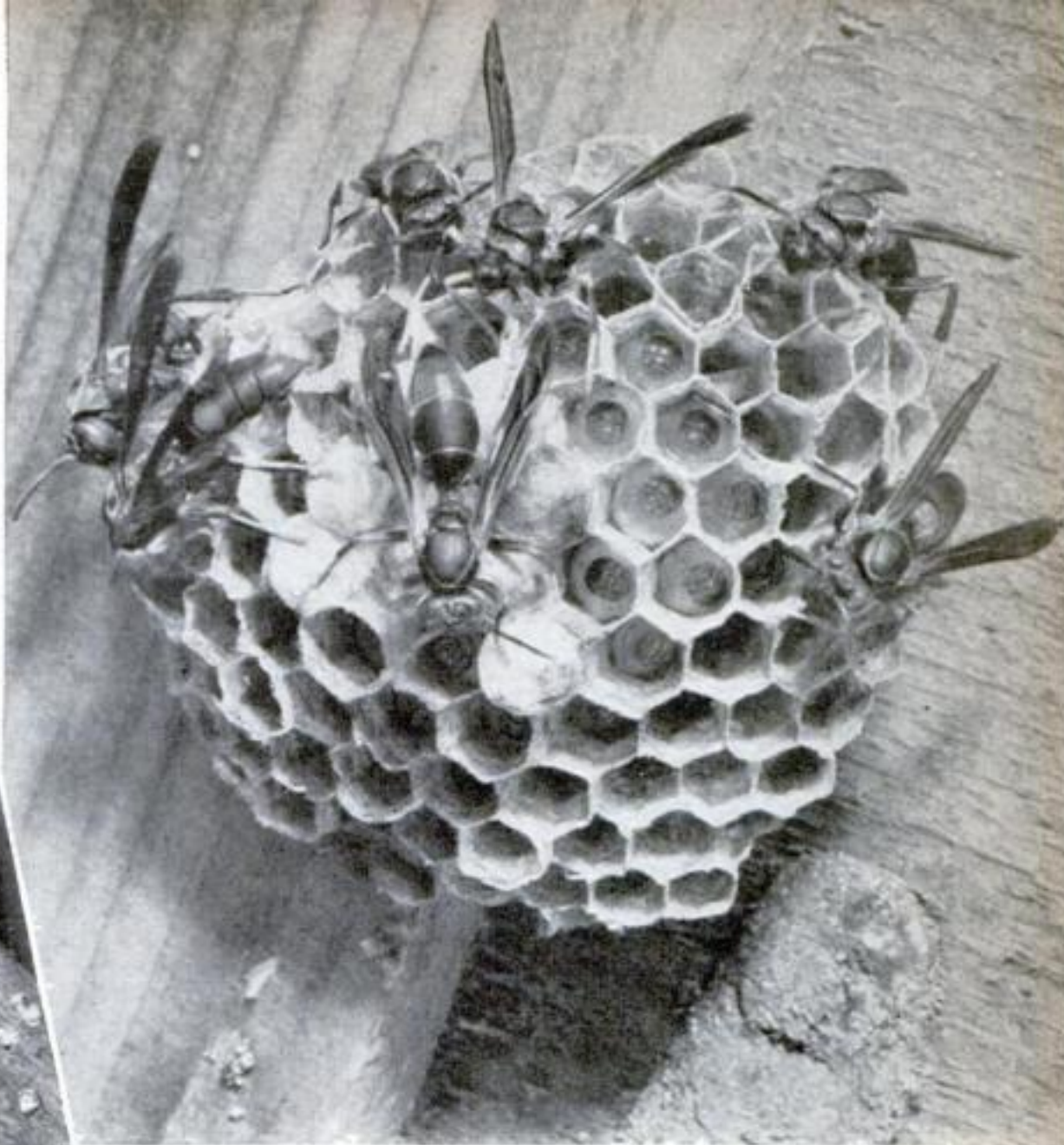
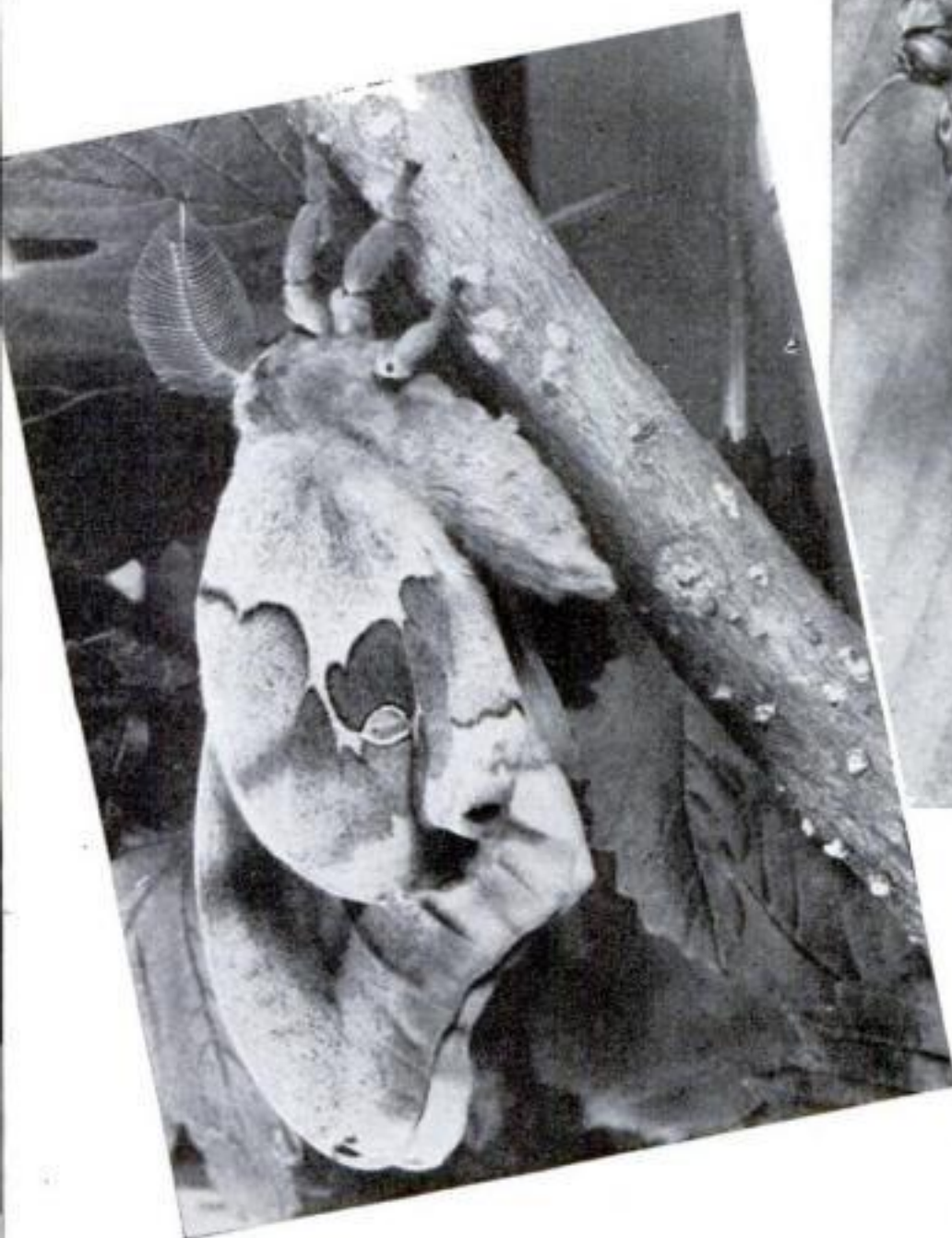
Capitalizing on the fact that chilling decreases the activity of insects, I once obtained a sequence of pictures showing the rise and fall of a wasp colony. All of the pictures, made over a period of several months, were snapped soon after dawn while the insects were still sluggish from the night chill. Similarly, the placing of an insect in a refrigerator for 10 or 15 minutes before taking a picture of it will diminish its activity so that it will cling where you place it and yet appear natural. In handling insects, particularly butterflies and moths, use tweezers, or lift them by their legs with your fingers. This will prevent damaging them or rubbing off their delicate wing scales.

When taking most insect pictures, it pays to stop the aperture of your camera to the limit. The old rule is, the smaller the stop, the greater the depth of focus. At $f/32$ the depth of focus is greater than at $f/4.5$. The closer you work to your subject, the less the depth of focus, and you need all you can get—especially when you enlarge, and still more



The praying mantis snares a katydid: a Proxar auxiliary on a Tessar, $f/32$, and photofloods. Right, a backlighted snowy tree cricket: $f/32$, the Tessar rear element alone

Quiet at dawn, paper-making wasps, right, cling to their nest, while a Polyphemus moth unfolds its wings below on emerging from the cocoon—both taken in daylight at f/32 with a Proxar on a Tessar lens, the wasps at one second, the moth at two



when you enlarge only a small portion of the negative. Using the camera on a tripod is virtually a necessity.

Starting with the largest insects, you can work to the more difficult ones, the real Lilliputians of their world. For butterflies and katydids, a Tessar 15-cm., f/4.5 lens is satisfactory. With the bellows extended to the limit, it records an insect almost full size on the negative. A 50-percent increase—pictures that show the subject $1\frac{1}{2}$ times natural size—is obtained by slipping an auxiliary Proxar wide-angle lens on the Tessar. This permits a closer picture of the subject. A double-size image can be obtained by removing the Proxar and screwing out the front element of the Tessar. With only the rear element in use, the depth of focus, even with the diaphragm stopped down to the limit, will be almost paper thin. This makes extra care in focusing imperative.

For the smaller insects, and for recording the amazingly odd faces of many species, I remove the Tessar entirely and replace it with a 1" focal-length lens originally made for a 16-mm. movie camera. This little ob-

jective is set in a wooden mount designed to slip snugly into the opening left by the removal of the Tessar and its Compur shutter. When the bellows is extended as far as it will go, the small lens throws an image 12 times natural size on the ground glass. This equipment is used only with photofloods or other artificial illumination. As the lens has no shutter, exposures are controlled by switching the lights on and off. With two photoflood bulbs 8" from the subject, the exposure is 16 seconds with superspeed film.

Insects should be freshly killed in cyanide before portraits of their faces are made. The heat of the lamps will stimulate anesthetized subjects, and they may move during an exposure. A few tiny insects, such as the $\frac{1}{4}$ " ambush bug, have the habit of remaining perfectly still while awaiting their prey, making it possible to record magnified pictures of living insects.

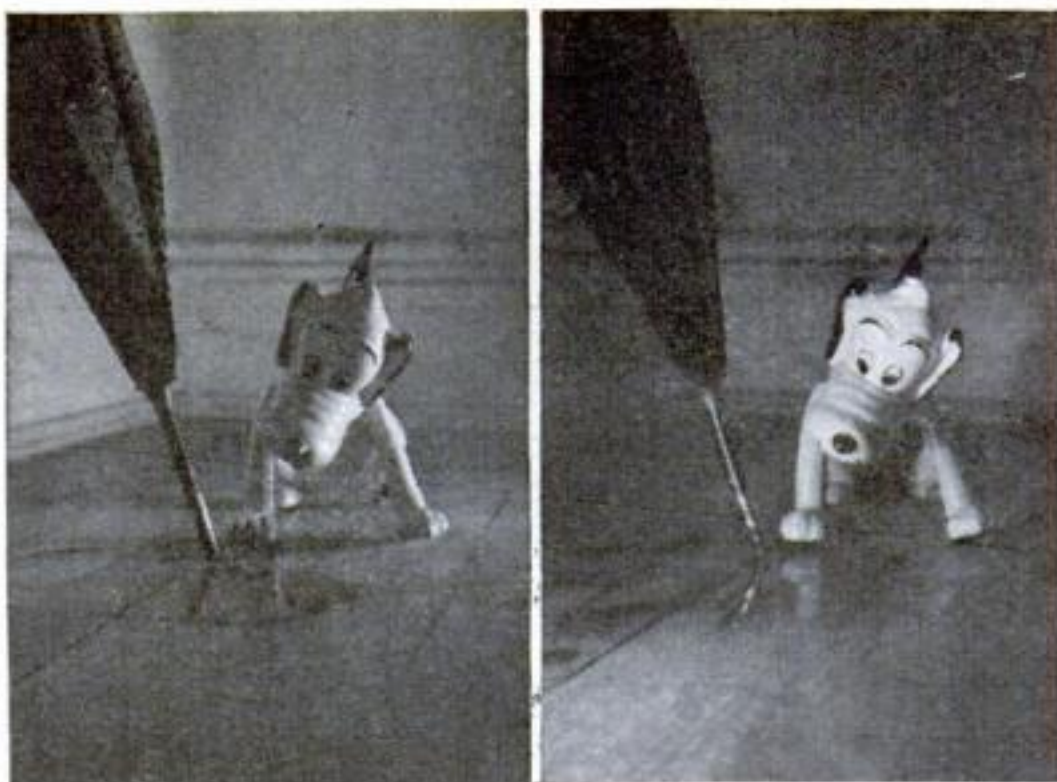
Filmy creatures, like the lacewing fly and the Luna moth, take on added beauty when recorded indoors with back lighting. Some insects and the plants to which they cling make unusual silhouettes when a photoflood is directed on white cardboard behind them.

Supersensitive panchromatic film is most satisfactory for insect photography. Its high-speed emulsion permits shorter exposures with the diaphragm stopped down, and its sensitiveness to all colors, including red, is valuable in recording patterns. As an aid to enlarging small portions of a negative, a fine-grain developer should be employed. Use glossy paper to show maximum detail.

All-Around Lighting for Stills Obtained with a Single Bulb

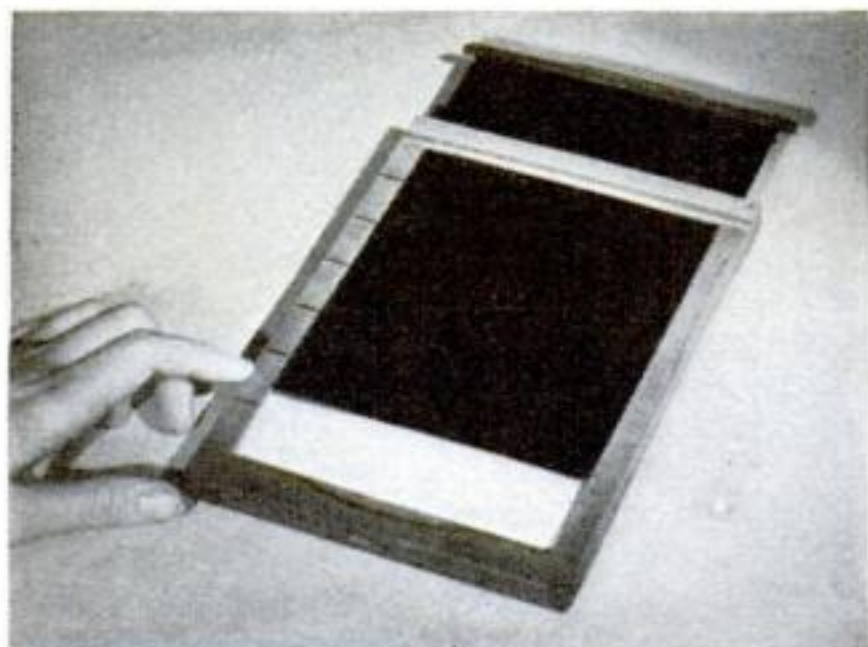


WHEN equipment is limited, a method of using a single bulb to get the effect of multiple lighting will prove useful in shooting still subjects such as table-top setups. The lighting is done from one angle at a time, separate exposures being made on the



This inquiring pup was lighted from front and side as in the shots above to get the combined effect at left

same film. Use a sturdy tripod and time each exposure for the lighted portions, as the shadowed areas will be illuminated when the bulb is shifted for the other exposures. You can control the effect or intensity of light for each angle of illumination by the length of the exposure or the distance of the bulb from the subject. Watch carefully where light from two angles may fall on the same spot, or you may overexpose. You can also light large interiors by this method if you move from place to place with the bulb, turning the light off each time instead of closing the shutter.—LOUIS HOCHMAN.

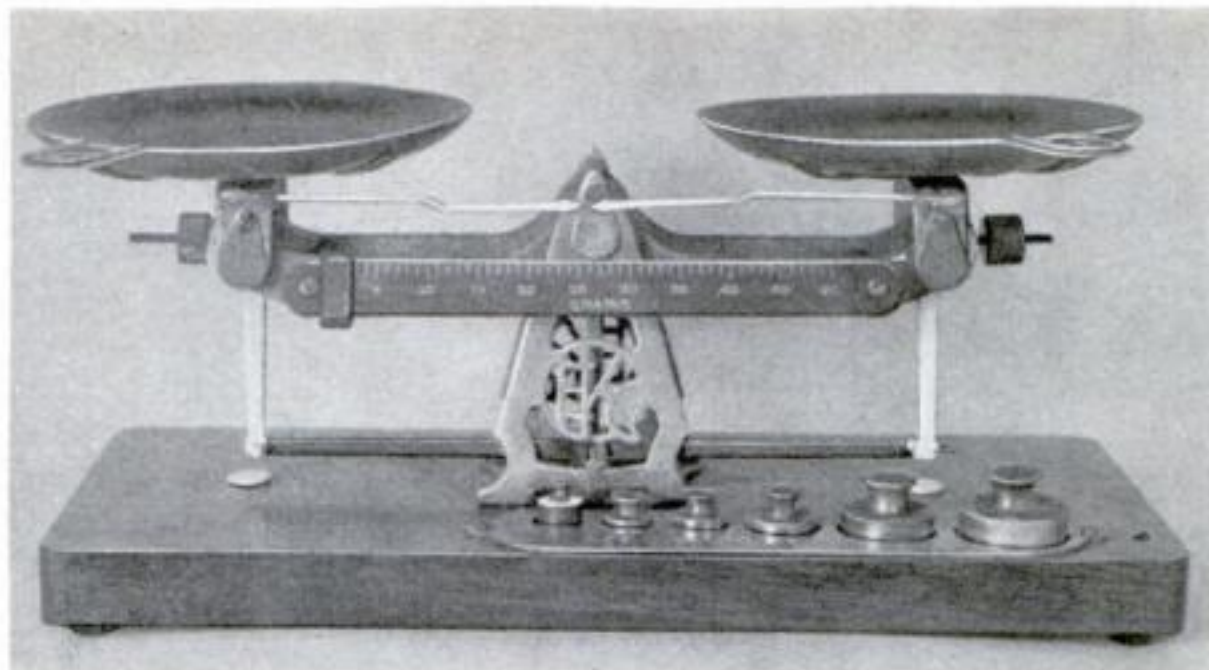


A CUT-FILM HOLDER will afford uniform test strips that save you time and paper in making trial exposures for enlargements. Insert unexposed paper in the sheath, fasten the holder on the enlarger easel, and draw out the slide at carefully timed intervals to spaces marked along the frame, as shown above. Developing the strip print will give you the nearest correct exposure for that negative.—JOHN K. KARLOVIC.

GLASS CASTER CUPS, such as are used to protect rugs from heavy furniture, are convenient for holding solutions when you are reducing local areas on prints or bleaching vignettes. If you are using two or more solutions, the cups should be labeled.



INDICATORS for your darkroom scale will give more accurate readings when you measure small amounts. They can be made from stiff copper wire and soldered directly to the yokes of the pans, as shown in the photo at the right. The hands of the indicators are hammered and filed to shape. A touch of luminous paint will make it easy to balance the scale pans even in the dark.—LOUIS SONKOY.



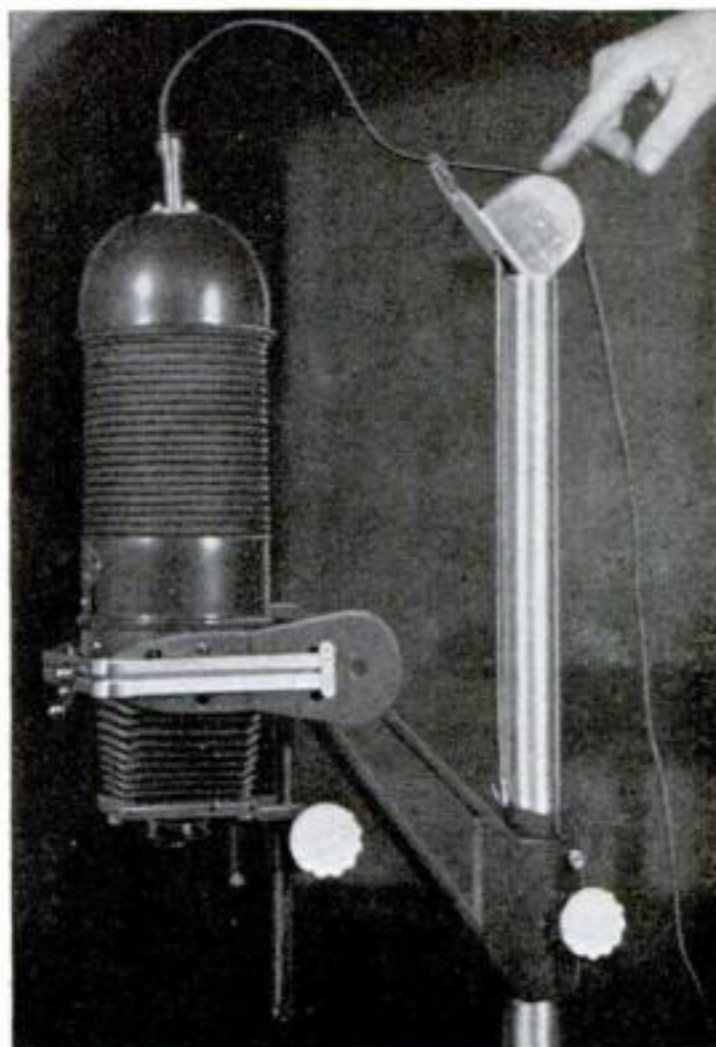
GLOSSY PRINTS can be tinted with regular photographic water colors if the surface of the print is first rubbed carefully with the open end of a freshly cut potato. The water colors will then flow on smoothly instead of drawing away into droplets on the surface. The print can be ferrotyped again to restore its glossy surface. As the potato dries, cut off thin slices each time you use it.—H. W.

BLOTTER LINT on photographic prints that have been dried between blotters adheres tightly to the emulsion and is often difficult to remove. A dry chamois cloth makes an excellent wiper for this job. Rub gently so as not to press the lint particles into the emulsion. The chamois should be washed frequently and wrung thoroughly dry before it is used again.



CABLE RELEASES that have lost their tension need not be thrown away. Obtain a small compression spring for a few cents at any hardware store. Work the spring over the head of the plunger so that it fits around the shaft between the head and the base as shown at the left. This will restore your cable release and make it useful once more.—S. ADELMAN.

A SPRING COUNTERBALANCE makes easier work of adjusting an enlarger to obtain the size image desired. Buy a spring sash balance having an 8 to 10-lb. pull at a hardware store. Wedge the balance firmly in the top of the enlarger shaft and attach the tape to the enlarger head to "float" its weight, as shown below.—R. E. WHALLON.



TAGS FOR LABELS on your darkroom bottles are more serviceable than pasted labels since they do not wash off or become stained. Also, they can be changed easily with each fresh solution or new data. Cut them from shipping tags and attach to the neck of the bottle with string or rubber bands as at the left. Tags of different shapes will aid in identifying bottles in the dark.—L. H.



This pair of eggs is laid in a nest of straw to begin the hatching period



These two squabs are just a week old and have only a thin covering of fuzz



After another week they still have little fuzz, but are growing rapidly



Three weeks of life produces added weight in addition to real feathers



The squabs are feathered and ready for eating four weeks after hatching

ONE luxury food everyone may enjoy without ration stamps is home-raised squab. The flesh of this delicacy contains more body-building soluble protein and less connective tissue than does the adult pigeon. In addition, it is an excellent source of vitamin G, is rich in phosphorus, and has a fine texture and a delicious flavor.

Of the many breeds of pigeons, only a few are generally used for squab production. They include the prolific King, the slightly smaller Carneau, the giant Homer, the French Mountain, Swiss Mondane, Hungarian, Maltese, and Runt. The first

28-Day

FAST-GROWING SQUABS PROVIDE

four are recommended by professional squab raisers because the squabs provide generous servings, some weighing 1½ lb.

Part of an outbuilding may be used for raising squabs, or a coop may be built. The house should include a protected pen, where the birds will be safe against wind and rain, and a screened yard. It should face south if the climate is cold, and it should be on soil that drains well. An open-shed pigeon house 6' high in the rear and 7' to 8' high in front, with an 18" projection on the front as protection against storms, is easily built. The depth of the house depends upon the number of pigeons to be mated. A pen 8' by 12' will hold 25 pairs easily. Houses are generally built of wood and are much like poultry houses. In very cold regions, enough heat to keep the house dry and comfortable (about 40 deg. F.) will

Pigeon nests are built in two sections because the hen often lays another pair of eggs before the two squabs occupying the adjoining nest have grown to maturity



help to increase the production of squabs during the wintertime.

Double nests are essential. Nest compartments may be 15" high, 12" wide, and 25" long, with a partition at the center and a 5" board in front to keep nesting material from falling out. A 5" landing board should also be provided in front, and each double nest should be partitioned off from its neighbor. Tobacco stems, long-leaf pine needles, straw, and hay will make satisfactory nesting materials for the birds.

The outside yard should be about 20' long

mated pair. Nest boxes may be closed with a wire or wood screen for use as mating coops.

Good couples should produce 12 or more squabs a year. The hen usually lays one egg, skips a day, then lays again, and 17 or 18 days later the two eggs hatch. The parents build their nest together and alternate in sitting on the eggs. Often the hen lays another setting of eggs when the young are two to three weeks old, leaving their feeding largely to the male. It is for this reason that double nests are provided. Both par-

Meat Miracle



A DELICIOUS PROTEIN FOOD TO SUPPLEMENT FAMILY RATIONS

and as wide as the pen. If available, 1" wire mesh is suitable to inclose it, but laths or similar pieces will serve. The sides should be 7' high. Be sure to extend the wire 12" into the ground to keep out rats.

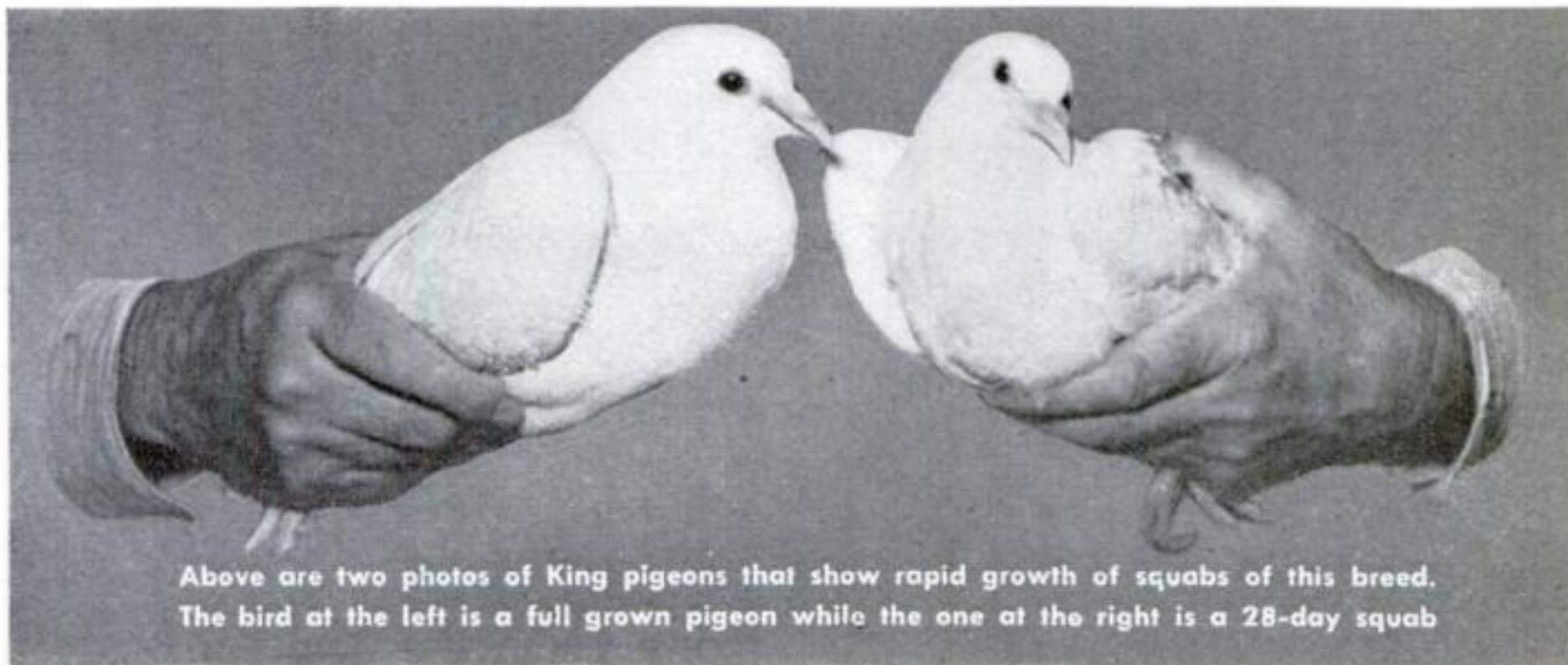
Select your breeding stock with care, going to a reliable breeder who keeps records of production and the weights of squabs, and will guarantee the sex and age of his birds. Purchase either young pigeons that are nearly ready for breeding or young mated pairs. With care, you can start breeding birds when they are six to eight months old and continue breeding them for five years. Keep only mated birds in the pen.

Once breeding stock is installed, nature may be allowed to take its course in mating, or the mating may be forced. Both methods are satisfactory. To force mating, confine a male and a female bird within a compartment for a week or two, making sure to provide feed and water. Place identification bands bearing the same number on each

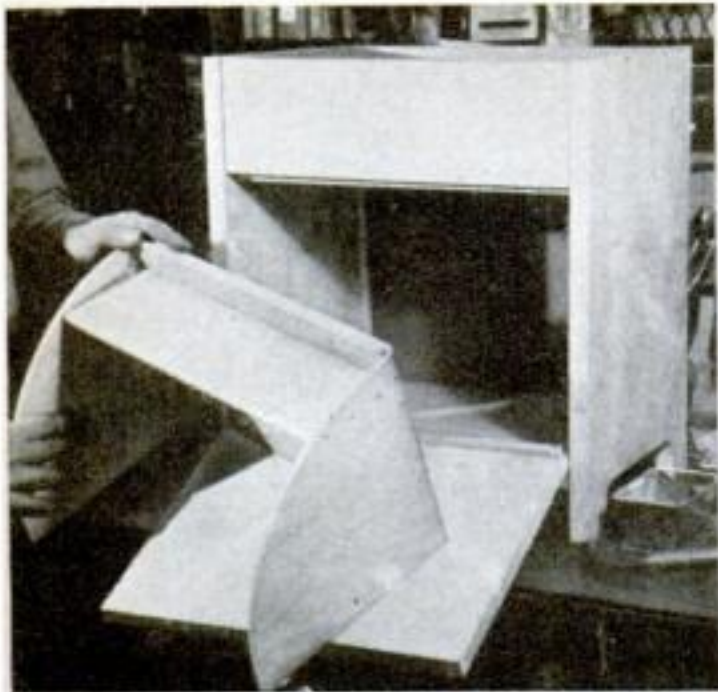
birds. Mated pairs will usually mate themselves. Parents feed their squabs on thick pigeon milk, produced in their crops, shortly after they themselves have been fed.

Retain squabs to be used as breeders in the pen with their parents until they are seven to eight weeks old, or until they learn to eat and care for themselves. For general feeding give whole grains, but no mash or green feed. Farmer's Bulletin No. 684 of the U. S. Department of Agriculture gives precise information on feeding and care.

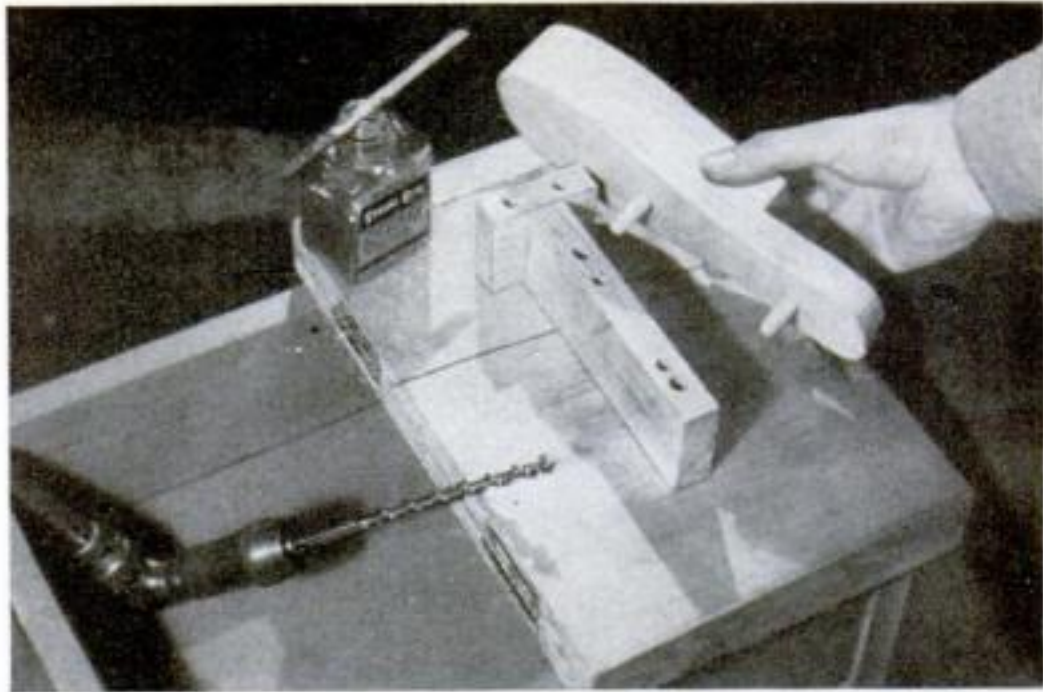
Given plenty of feed and water, and kept clean and dry, the squabs will grow rapidly. Those for the table should be killed when they are 24 to 30 days old and before they have left the nest. Surplus squabs may be sold, thus reducing the cost. Immediately after killing by severing the jugular vein just below the base of the skull, dry-pick the birds and remove all pin feathers. Cool the picked squabs promptly by immersing for three hours in ice-cold water containing 1 part salt to 32 parts water.



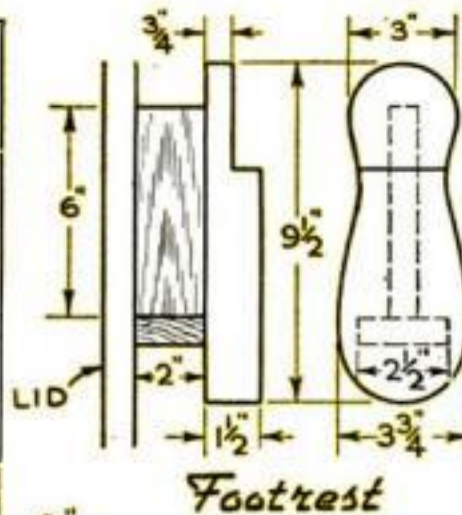
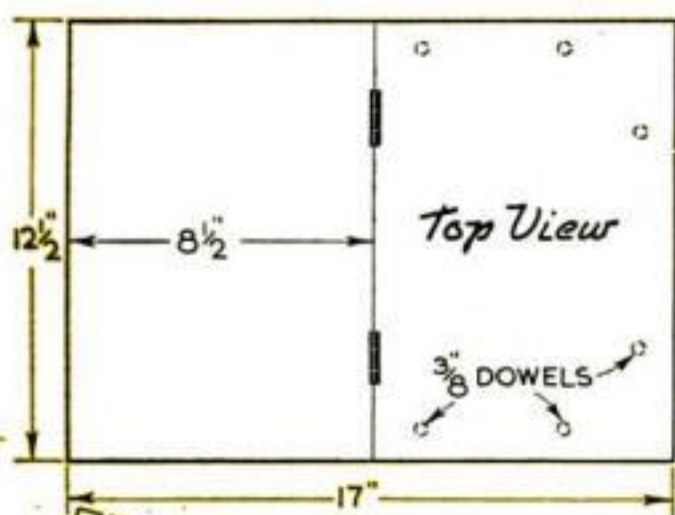
Above are two photos of King pigeons that show rapid growth of squabs of this breed. The bird at the left is a full grown pigeon while the one at the right is a 28-day squab



The plywood storage bin is attached to the down-swinging door with glue and set nails

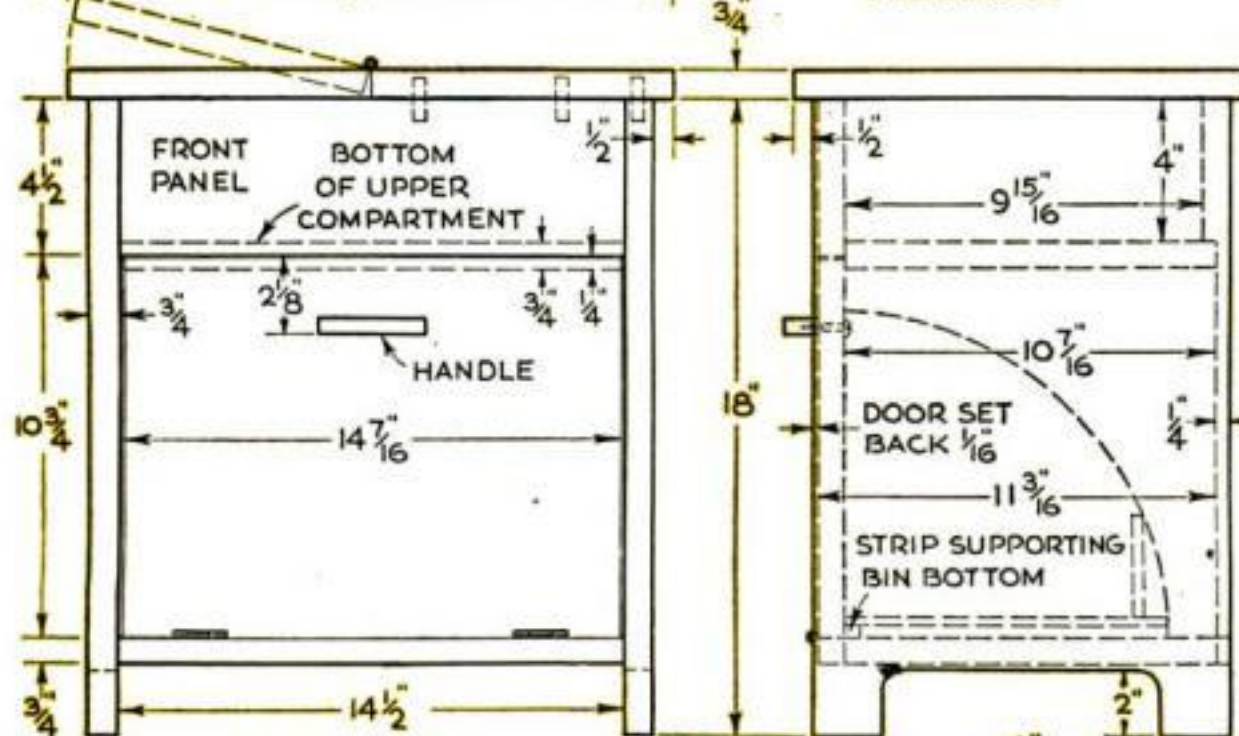


A T-shaped base, nailed to the underside of the hinged lid, raises the footrest to a convenient height for polishing

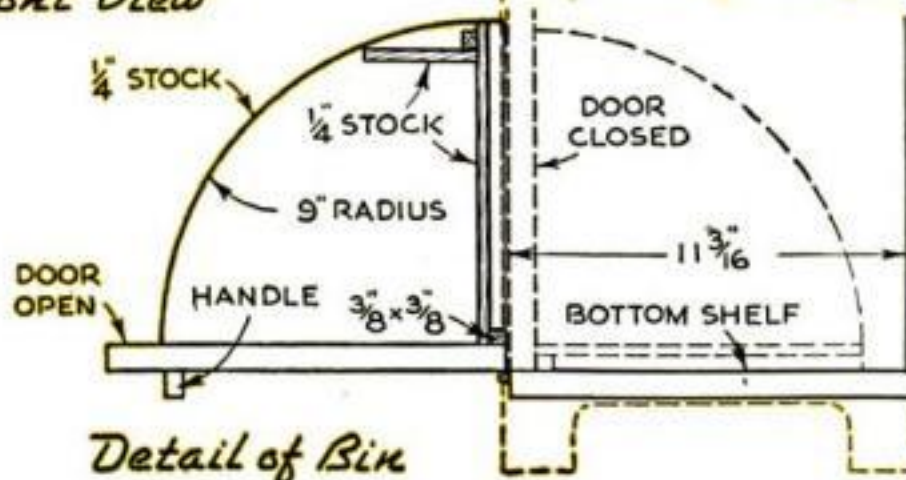


SHINE

ON THIS STURDY
THAT SERVES



Front View



Detail of Bin

MATERIALS

No. Pc.	Description	T.	W.	L.
2	Top	3/4	8 1/2	12 1/2
2	Sides	3/4	11 1/2	18
1	Front panel	3/4	4 1/2	14 1/2
1	Back panel (plywood)	3/4	12	14 1/2
1	Front door	3/4	10 3/4	14 7/16
1	Back (upper compartment)	3/4	4	14 1/2
1	Bottom (upper compartment)	3/4	10 7/16	14 1/2
1	Bottom (lower compartment)	3/4	11 3/16	14 1/2
1	Footrest	1 1/2	3 3/4	9 1/2
1	Footrest support	3/4	2	6
1	Footrest support	3/4	2	2 1/2
1	Bin bottom (plywood)	3/4	9	13 15/16
2	Bin sides (plywood)	3/4	9	9
1	Bin back (plywood)	3/4	3	13 15/16
1	Stock for bin cleats	3/4	32	

Miscellaneous: 2 pair hinges, 1/2 inch wide; 1 ivory plastic door handle.
Note: All dimensions are given in inches and are finished sizes.



Plastic handle swings open the front door to reveal storage space where brushes and polish may be kept

'EM UP...

SHOE-POLISHING CABINET THE WHOLE FAMILY

By Vernon B. Case

ALTHOUGH a shoe-shine cabinet needs to be practical, it doesn't necessarily have to be an ugly piece of furniture. Here is a cabinet that is thoroughly functional but at the same time has pleasing lines and could even be used as an end or hall table. It provides space for storing brushes, polishing cloths, and bottles or boxes of polish. In addition, it has a convenient footrest that swings into position when the left half of the top is opened.

The cabinet shown was built of white pine and finished in two tones of colored enamel. However, almost any wood that is reasonably easy to work and does not have loose knots will do.

Both of the sides are cut away at the lower ends, as shown, to form short legs. This can be done on a band saw, a jig saw, or even with a small keyhole saw.

Use nails and glue to fasten the parts together. Set the nail heads rather deep and plug the holes over them with plastic composition wood, crack filler, or wooden pegs.

The top is in two sections, one of which



Here's a cabinet that can take care of the entire family's shoe-polishing needs. Extra cans of polish can be kept under the lid, alongside the footrest

swings upward like a trap door. In joining the two top pieces with a pair of hinges, take care to align the upper surface as perfectly as possible. This can best be done by clamping both halves in a vise while attaching the hinges. The fixed portion of the top is held in place by six $\frac{3}{8}$ " wooden dowels spaced uniformly and secured with glue.

A footrest, raised on 2" strips arranged to form a T, is mounted on the lower surface of the hinged lid in such a way that it does not strike the sides of the cabinet when the lid is closed. Attach the strips to the lid with long screws or nails and fasten the footrest to them with glued dowels or countersunk nails.

The front door of the cabinet, hinged at the bottom, swings outward to provide access to the storage compartment fastened to it. The bottom board to which the door is hinged extends to the back of the cabinet, and the rear of the compartment is closed by a piece of $\frac{1}{4}$ " plywood to exclude dust.

To carry the cabinet, simply swing the lid back and grasp the two hinged edges.

NOTE DIRECTION OF GRAIN WHEN CUT FROM LUMBER

NATURAL CROOKS AVAILABLE, Knees can be hammered

NATURAL KNEES SHOULD BE REINFORCING

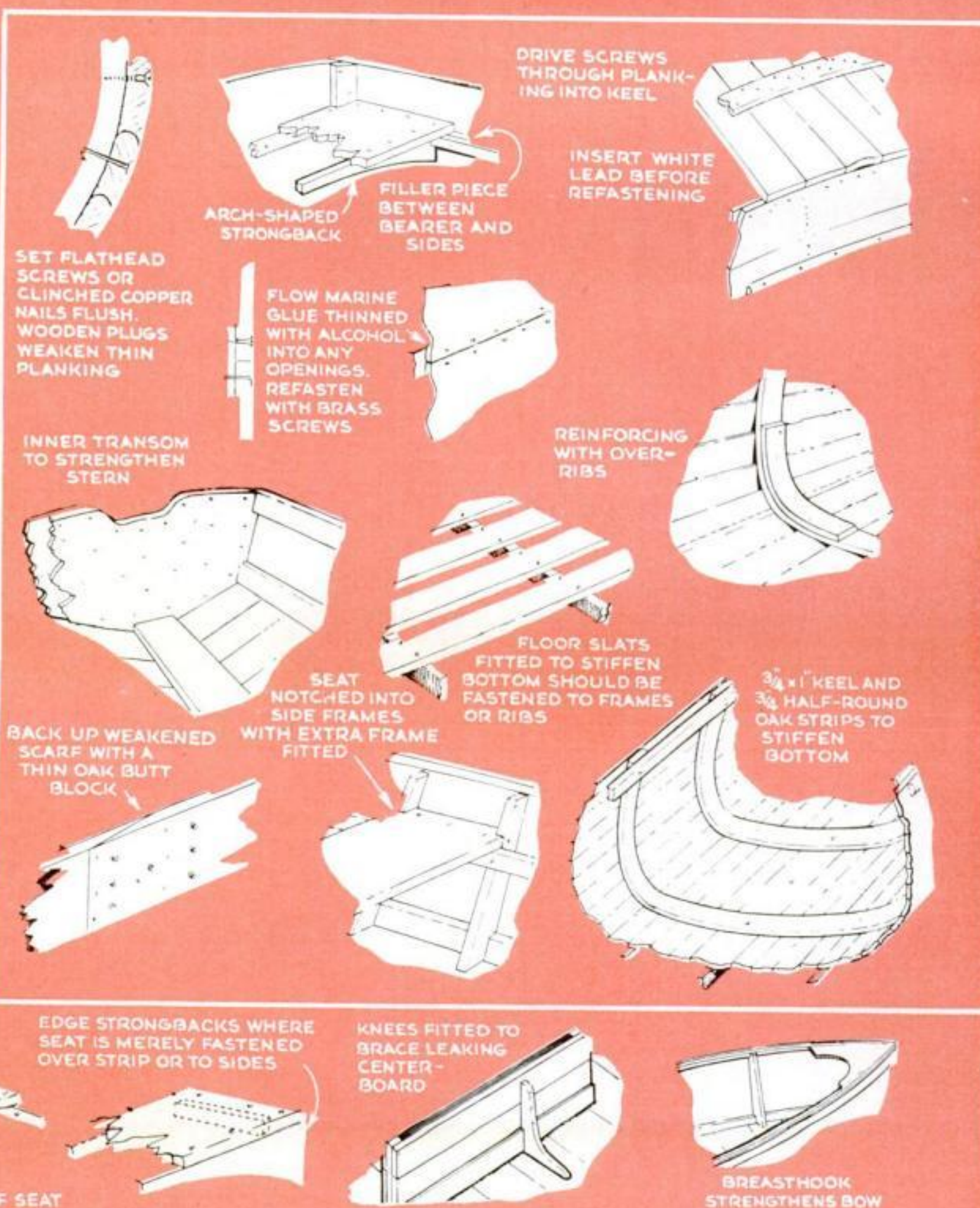
USE OF WATER-PROOF PLYWOOD GLUED TOGETHER

JOIN ADJOINING RIBS INTO KNEE WHERE POSSIBLE

USED TO TIE BOTTOM TO SIDES (BOTTOM NOT SHOWN)

WIDENESS FITTED TO CROSS LENGTH

X STRONGBACK PREVENTS SAGGING OF SEAT



Stitch-in-Time BOAT REPAIRS

WILL MAKE YOUR CRAFT LAST LONGER

CLINCHING

RIVETING

BORE HOLE
FOR TIGHT FIT

IRON

DRIVE NAIL
AND START
POINT

PUT WASHER ON
AND NIP OFF
EXCESS LENGTH

CONTINUE
TURNING
POINT WHILE
DRIVING

NAIL
CLINCHED

RIVET WITH
IRON AGAINST
HEAD

USE LONG RIVETS
OR NAILS AT LAPS

BETWEEN LAPS,
DRIVE RIVETS
ONLY WHERE
PLANK HUGS
RIB

KNEES USED
AS SIDE AND
BOTTOM FRAMES

WINTER storage or temporary laying up of a boat is an important period in its life. Mere shelter from the elements is not enough. To keep your boat in good condition, it is important to make small repairs before storing it, while they are still simple and easy to do.

Skiffs and heavily planked small boats usually stay in good condition with a minimum of care, as their stout hulls stand much abuse. Lack of care is likely to result in bothersome leaks rather than in a major failure. However, if such a boat is to be stored outdoors, protection should be given the bottom. Mark leaking spots while it is still in the water. Repairs should be made promptly after the boat is hauled out. While dirt is still damp and easily removed, wash the hull inside and out with a strong soap solution and a stiff broom. Scour off old paint to avoid building up successive layers that will eventually require burning off. If the paint or varnish is badly checked, remove it with a blowtorch or paint remover.

Block up the inverted hull at both ends and amidships above high water, and high enough off the ground to allow free circulation of air. Level the blocking to prevent warping of the hull. An old tarpaulin secured all around, waterproof roofing paper, or untreated canvas covered with closely laid board will afford protection from sun and wind that dry out planking, and keep out rain and melted snow that might run into seams and freeze in cold weather, causing splitting and buckling.

In buckled bottom boards, a common trouble in this type of boat, bore slightly undersized holes for long, flathead screws or galvanized boat nails, staggering the holes between old nails. Use two or three to an end. Be sure to drill sound wood, preferably hardwood of chines or transom liners. Clean out open joints, allow them to dry thoroughly, then work in white lead before refastening the planks. In extreme cases, work a very small amount of soft calking or absorbent cotton in with the paste.

Give special attention to the joints where the last bottom plank and the ends of the above-water planks fasten to the stern transom, as most skiffs leak there when fully loaded. If the transom and sides are unlined, shaped oak pieces should be fitted to give a better hold for plank fastenings. In a skiff with a hardwood keel, drive the fastenings through the planking into the hardwood. If there is no keel, fit one of $\frac{3}{4}$ " by 4" oak to add stiffness.

Hard calking can do more harm than good. Never calk a dried-out boat. Let it swell; then mark leaking seams for attention. Calk the entire seam rather than the leaks only. If a leak is too small to warrant this, taper the ends of the calking, or new leaks may start



Laying deck canvas on the cabin of a 20' motorboat. The owner is filling the canvas with dilute cement before replacing the trim and painting three coats

at these points. Forcing twisted calking mixed with white lead or marine glue into a seam with a putty knife is satisfactory.

The hulls of lightly built boats often work loose and then leak. They can be stiffened by refastening, and by fitting new center seats or refastening old ones to tie the sides tighter. New gunwale strips or half-round, 2" stock, preferably oak, will stiffen the sides, especially if fastenings can be driven through from the inside. When an outboard motor is used, stern stiffness is important. A carefully fitted stern seat and properly shaped knees to tie the side and transom together will give that needed strength.

Light, smooth-planked boats, such as car-top models, require more care if they are to continue giving satisfaction. Winter care is important but should not be carried to extremes, such as storing the boat in a heated basement or other hot, dry room. Storage in an unheated garage or shed, or even in the open under a tarpaulin or boards closely laid over roofing paper, will prevent drying the wood too much. It is essential to block or support these lightly framed boats so as to distribute the weight equally.

Many boats with wide planking have their seams backed by battens for watertightness. If a leak has developed along such a seam, clean out any filler or dirt and work white lead into any large openings, and liquid marine glue thinned with alcohol or gasoline into smaller ones. Drive new fastenings from outside to pull the planking and batten together. As a last resort, tape the seam with muslin ironed over hard canoe glue.

Boats with narrow strip planking usually have the edges of the planking shaped for tighter seams. Nevertheless, permanent tightness depends on the wood not drying out too much. Both the outside and the inside of the boat must be kept well varnished or painted. In the case of a portable model likely to be out of water much of the time, protection from hot sun and drying winds is requisite. These boats are usually well built, but their light weight means lighter construction. Overloading, too fast running in rough water, or use of too powerful a motor will produce a strain, indicated by a tendency to weave or work while

running. If allowed to continue, this will result in leaking. Refastening, especially of the ends of bottom and side planking to stem and transom, and along garboards near the keel, will help here too. Small brass screws are best for such repairs.

A common fault is stern weakness, offset by fitting an inner transom—not so much to be watertight in itself as to provide new wood into which to drive fastenings and to stiffen the original transom against motor vibration. It should be fastened inside the regular transom over heavy, wet paint or liquid marine glue.

Seats are important as cross members in lightly built hulls. Their ends should be tied in well with fore-and-aft stringers, and small knees fitted where possible. New floor boards can be fitted to strengthen a bottom having a tendency to work or weave, but they will add strength only when fastened to every frame or rib. The middle board should be left loose for sponging out.

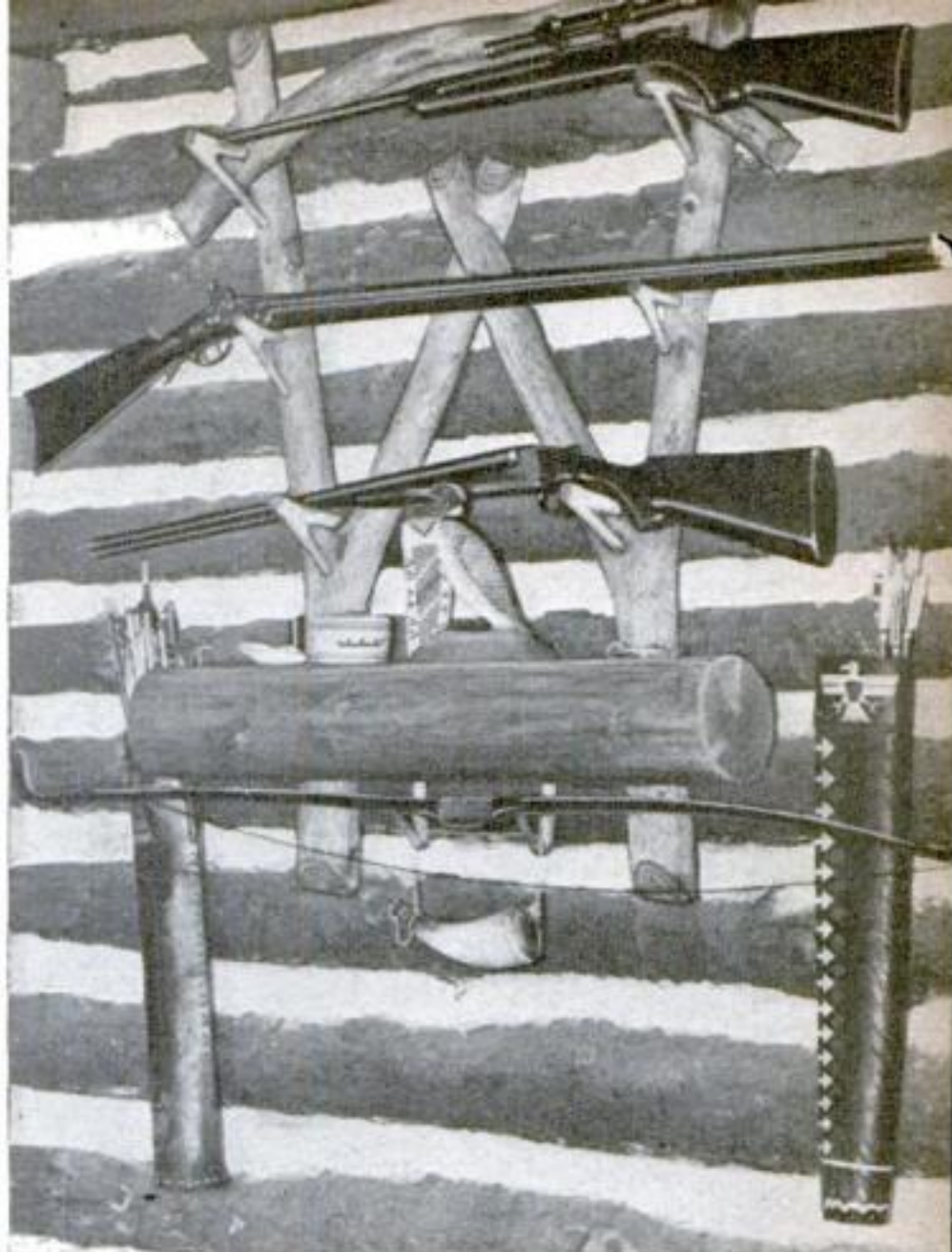
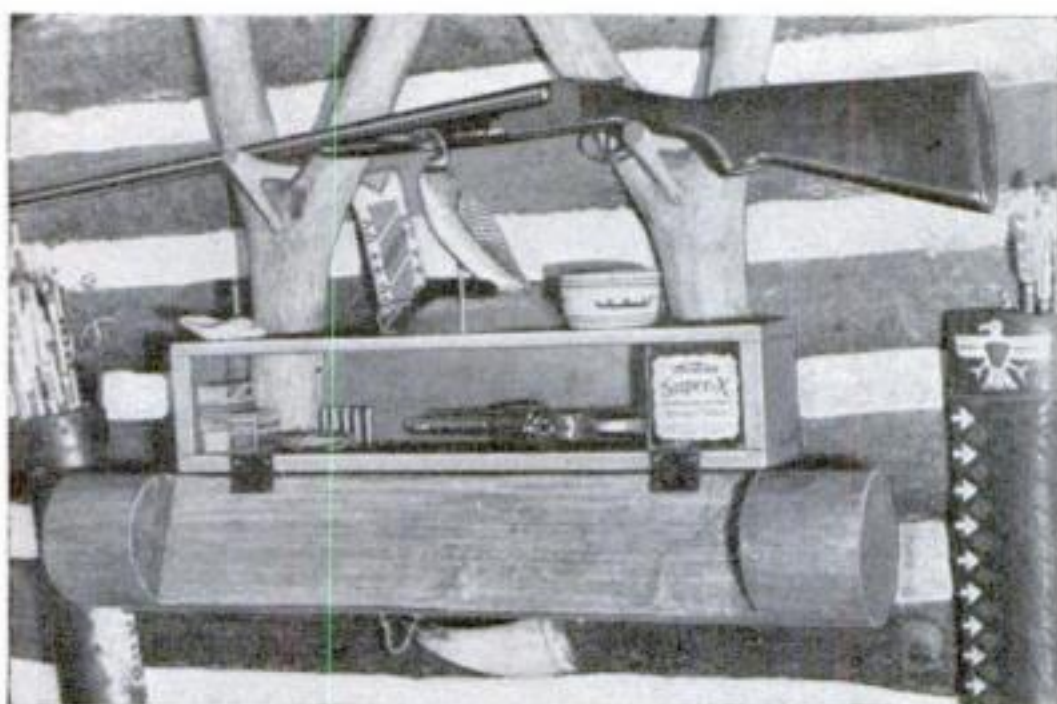
Lapstreak or clinker-built boats, if stored outside, must be protected from rain water or melted snow that might freeze in the seams. As the overlapped planking adds hull stiffness, the frames are often widely spaced. This throws considerable strain on side fastenings, and they become loose.

Copper rivets sometimes stretch under such strain. Old fastenings along lapped edges should be looked to if there is any evidence of play or leaking. In some cases, copper rivets can be drawn up tighter. Have a helper hold an iron against the heads while you strike a small rivet set held against the plain ends of the shanks to tighten the burrs. When short strakes have been used and their ends fitted with scarf joints having sliver ends, a thin oak block behind the scarf with fastenings through the planking into the block will add strength.

Taking up on the original fastenings of round-bottom boats with planking fastened to light but closely spaced ribs will help restore such boats to their original stiffness. As ribs for boats of this type are steam bent, breaks may have developed where the bends are sharpest. A new bent rib may be fastened over a cracked one, with the old one left in place unless it is rotted.

RUSTIC GUN RACK

HAS INGENUOUS
HIDDEN COMPARTMENT



To a casual observer, the log above is solid and merely adds to the appearance of the gun rack, but it hides a secret box compartment as at left

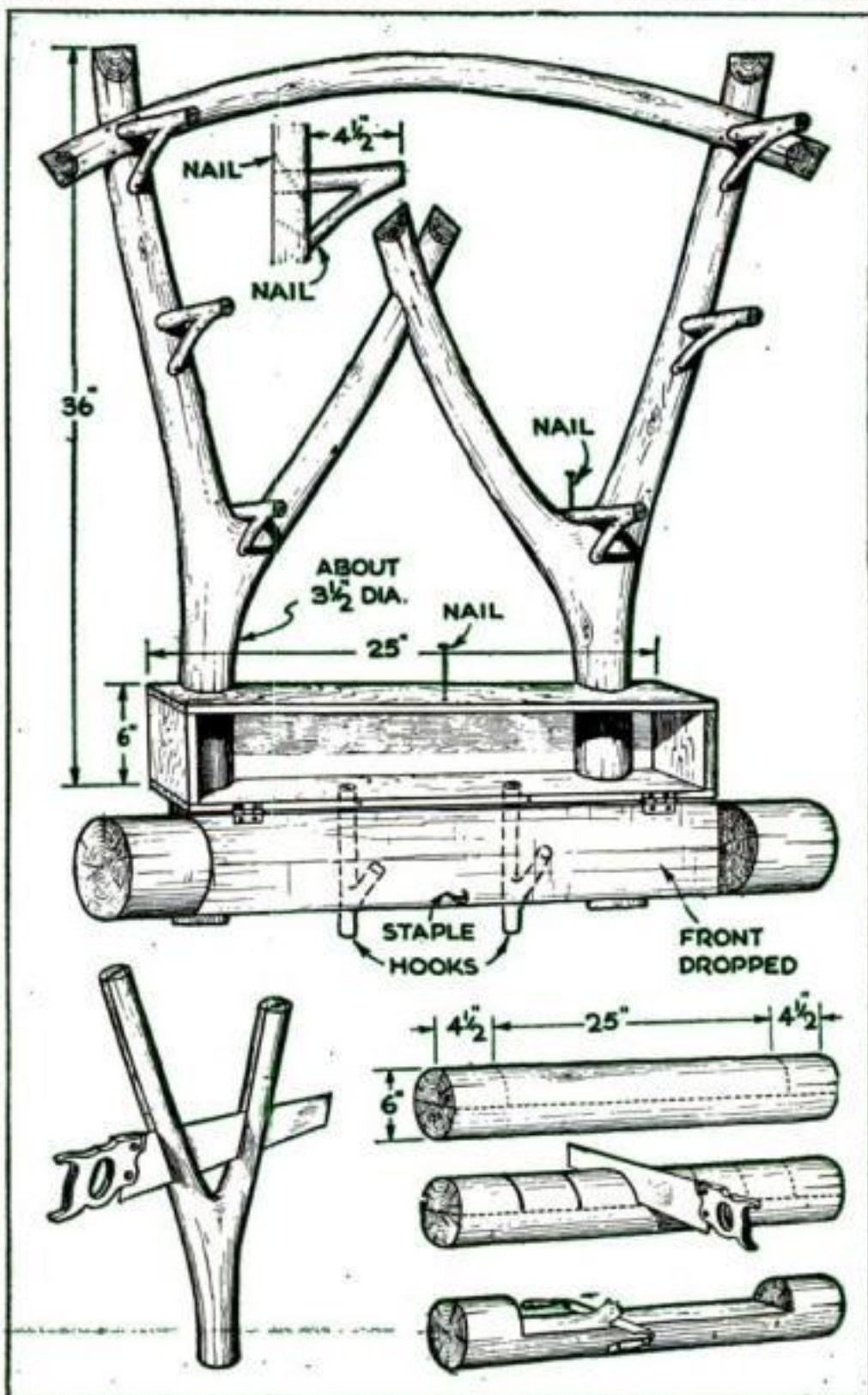
By W. BEN HUNT

SYMMETRY was achieved in this rustic rack by the simple process of sawing the large crotch in two lengthwise, as shown in the drawing. Remove the bark from all crotches as well as the log before sawing to be certain the wood is sound. The small crotches are fitted and nailed at a slight angle to keep guns from sliding off.

The log front is held closed by a nail with its head set flush in the shelf and extending down through the staple. The head of the nail is out of sight, yet can be lifted with the fingernail when a slight pressure is applied to the front of the log. Saw the log to the required dimensions, remove the wood with a wide chisel and drawknife, and trim the edges to make a neat fit with the box shelf.

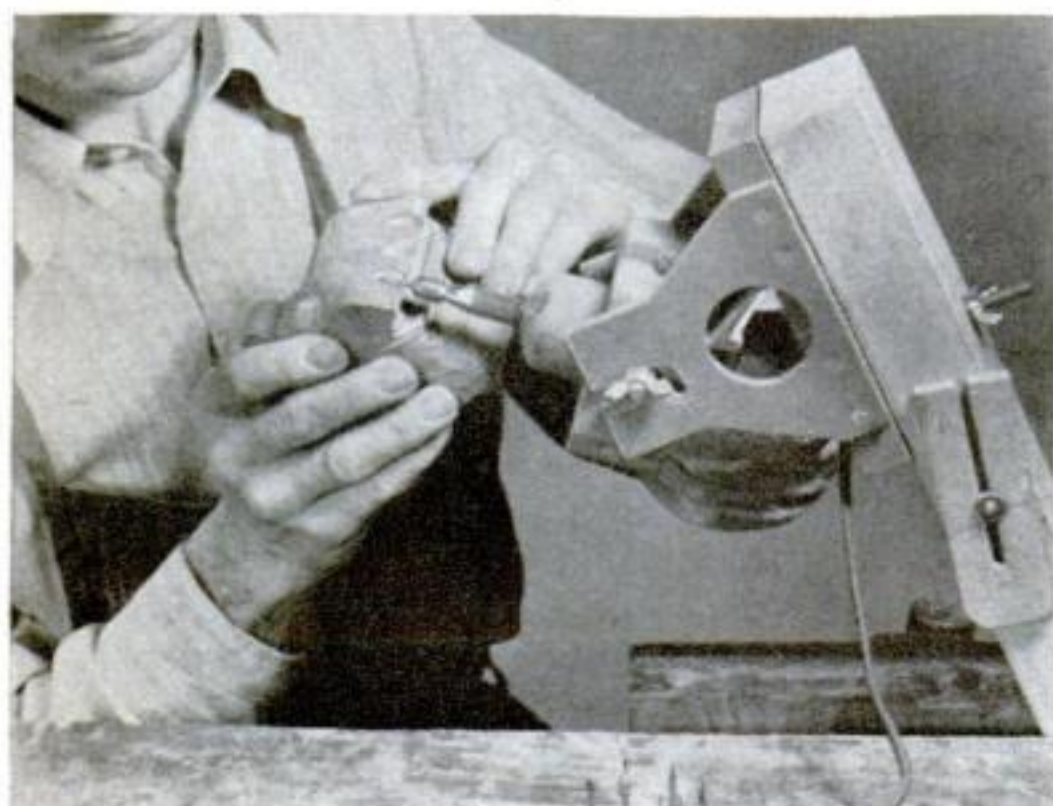
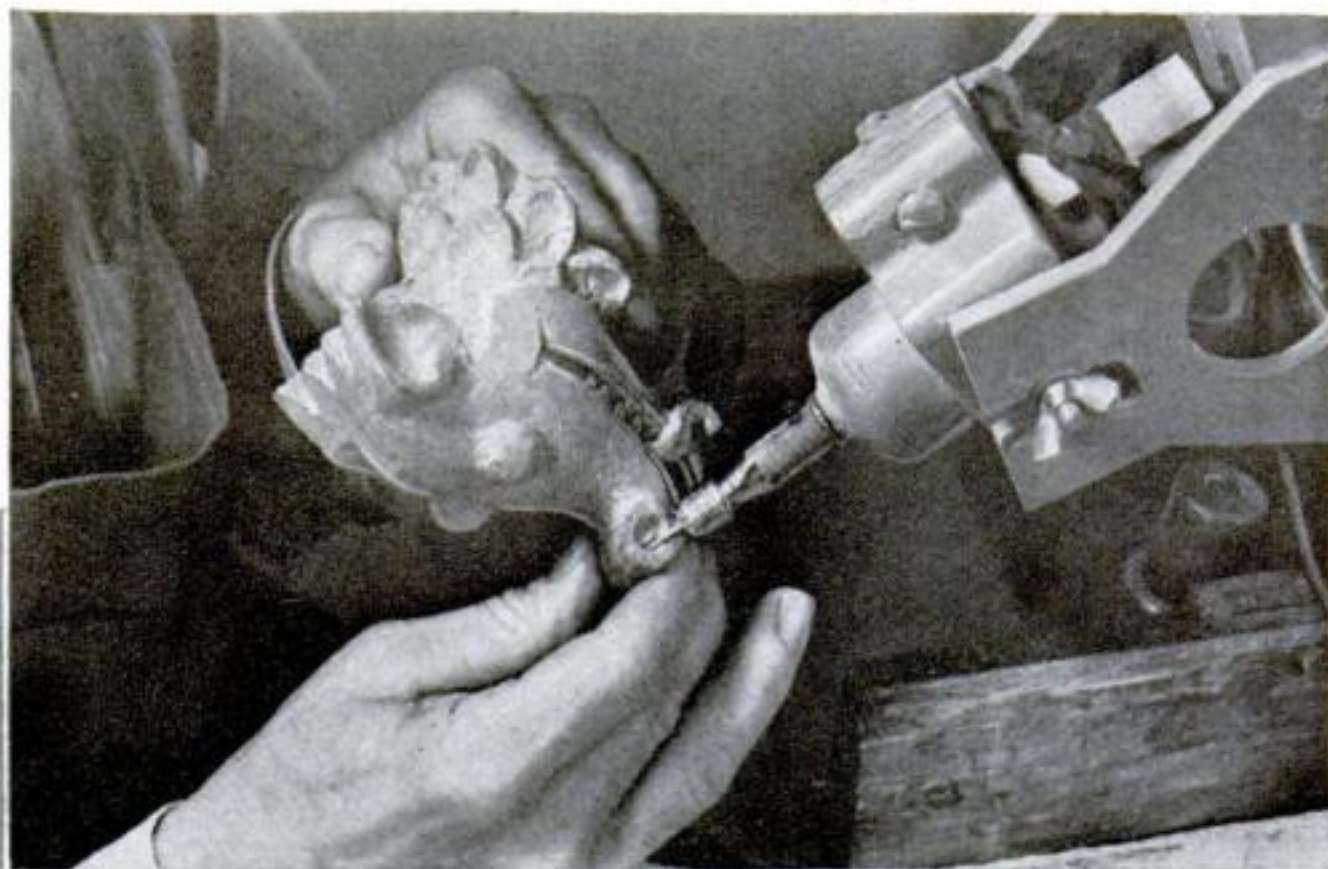
If a dead crotch that is of the right size and will lie flat when cut is not to be had, use a green one that you can force flat. Let it dry in the required position, but be sure to shellac the end and inner crosscuts so as to prevent excessive checking.

Take care in driving all nails to avoid the danger of splitting the stock. It is wise to first drill holes slightly smaller than the nails to be used. The dimensions in the drawing may have to be altered to suit the size of wood used. After the rack is thoroughly dry, finish with stain and varnish.



Decorative Carving with

Free movement for feeding work is possible when the carving motor is mounted rigidly. Below, one hand steadied against the bench top, the little finger can be used as a spring feed control. At bottom, rough cutting with a pear-shaped tool; at right, detailing with a medium ball point



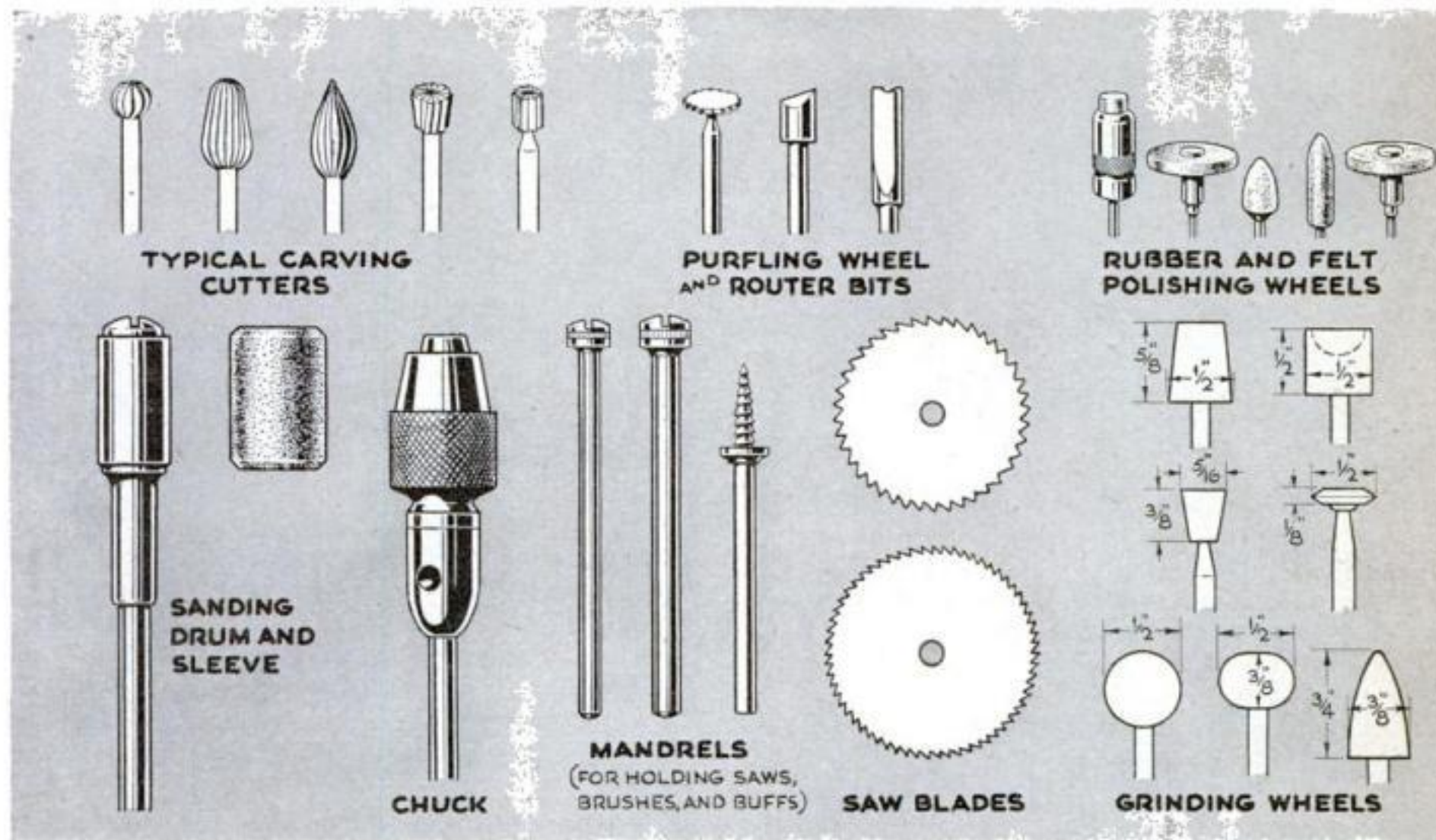
By Edwin M. Love

CARVING with a small motor or a flexible shaft is almost effortless, but extreme care must be exercised, for one false touch with a whirling cutter may mar wood or plastic irreparably. An advantage, however, is elimination of the propensity of hand gouges for splitting the wood, especially when coaxed across bad grain.

What cutters are needed for carving? Although many types are available, comparatively few are really required for most work. The carvings shown in the photographs were made with the five cutters illustrated in the drawing on the facing page. Three different sizes of ball cutters were used, ranging from $\frac{1}{32}$ " to $\frac{3}{8}$ " in diameter. Other special cutters will be convenient for certain details, but should be bought only as needed.

How is flat carving done? First, transfer the design to the wood with the aid of carbon paper. Bolt the motor mount to the standard. Rout the background, using a routing or cylindrical cutter and starting the initial operation in predrilled holes. Clamp the work securely; then carve down the various levels of the raised parts of the design with a large ball cutter. Adjust the depth of cuts by tilting the motor in its standard,

Miniature Power Tools



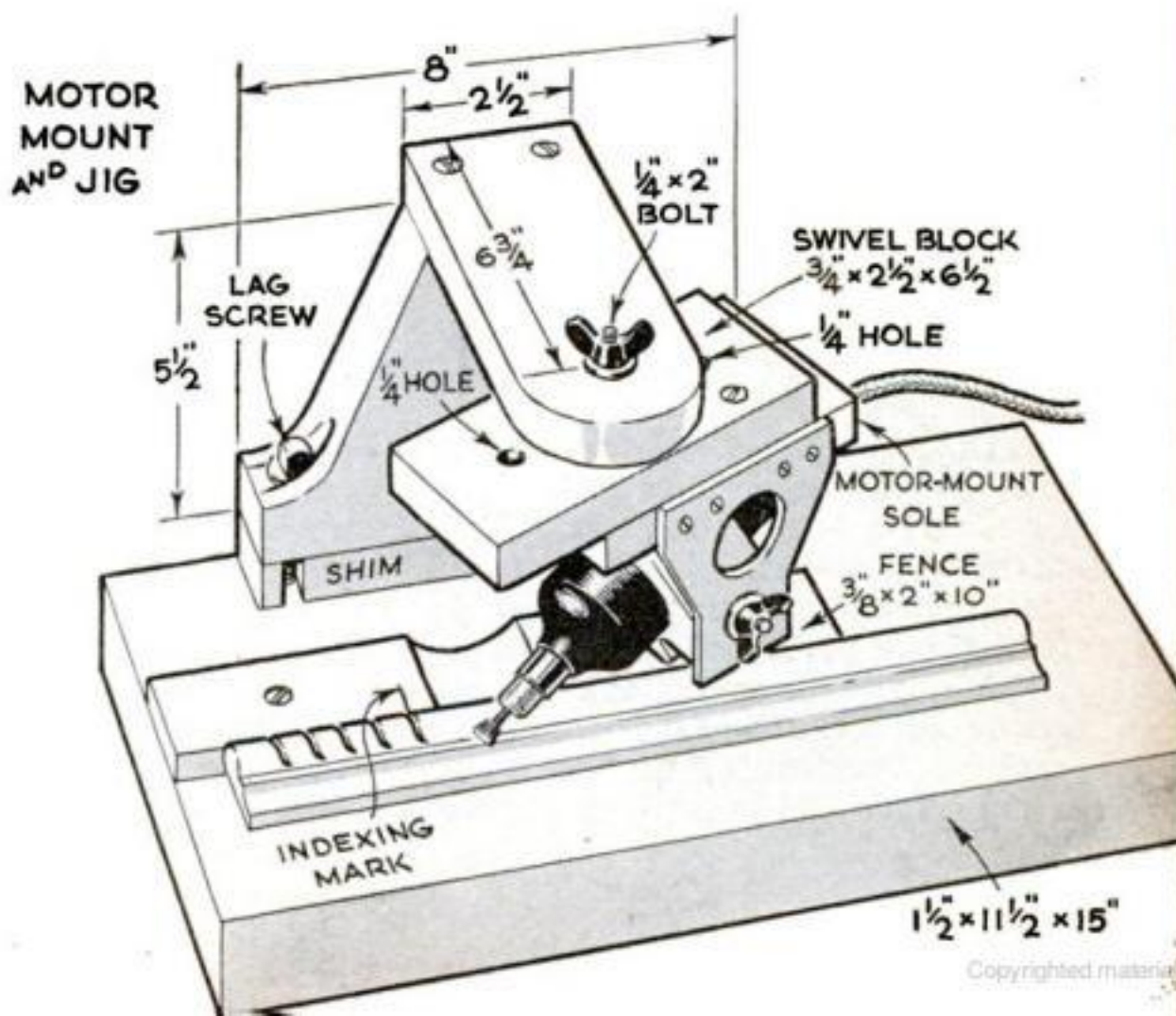
and handle the instrument as shown in the photos on page HW 474. When all the levels are established, outline the details of the design with a ball cutter of suitable size. The depth is controlled by the motor mount, but it can be varied slightly by rocking the mount with the fingers of the left hand. After first roughing the work with large cutters, touch up the various details with appropriate smaller cutters.

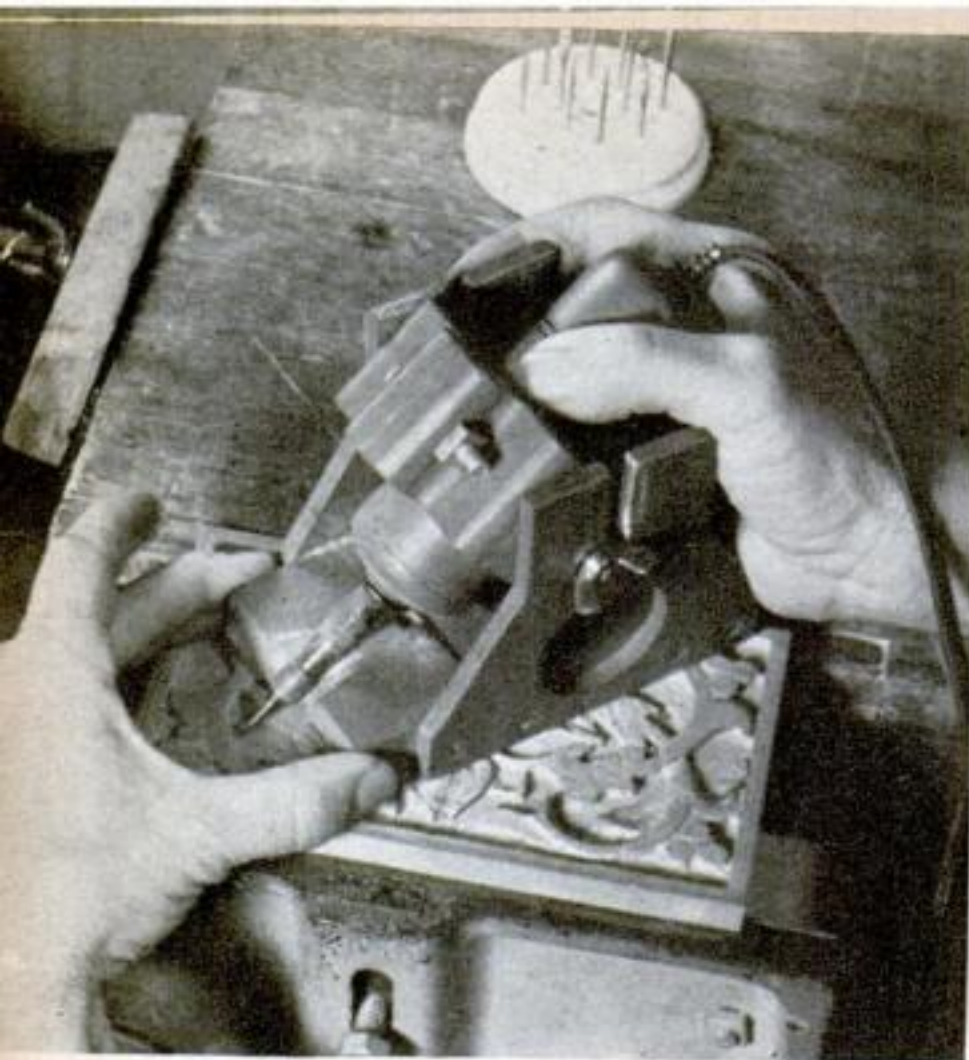
A general rule for carving is to work uniformly over the whole piece. The future balance of the finished piece can best be judged by this method. Large cutters and long strokes give simplicity and unity of treatment. Radial or concentric lines, and gradual rather than abrupt changes of direction and scale, tend toward better balance.

Carvings done by hand are seldom smoothed with a file or sandpaper, as the carving gouges leave more interesting surfaces. Sometimes the background is stippled with a grounding punch, although the texture left by gouges is usually preferable. However, chisel marks do not appear in mechanical carvings, so a

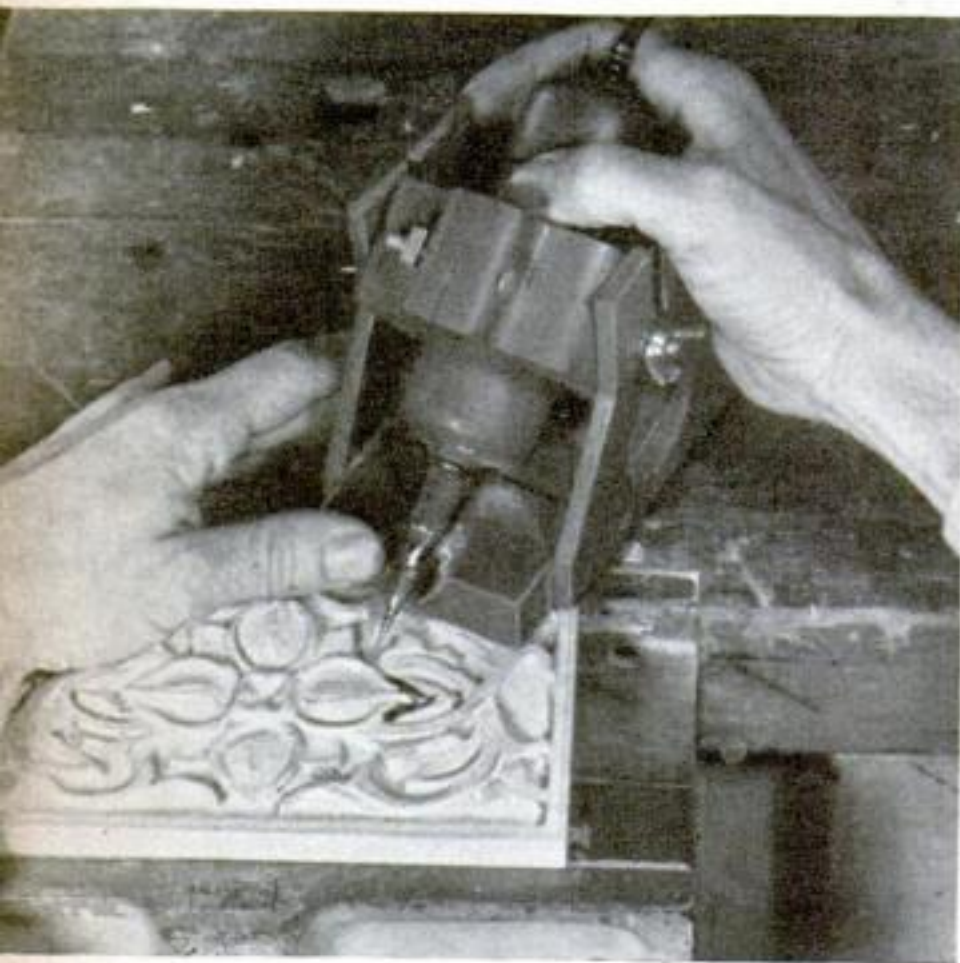
sanded finish is justifiable, although even strokes of the cutter will produce pleasing textures to be left unsanded.

What is the method for block carving? Transfer the plan and elevation outlines of the design to the block and bandsaw it to shape. Saw the side elevation first, tack the waste pieces back in place, then saw the plan contour. Corners can be trimmed with a coping saw. Fasten the mount and motor



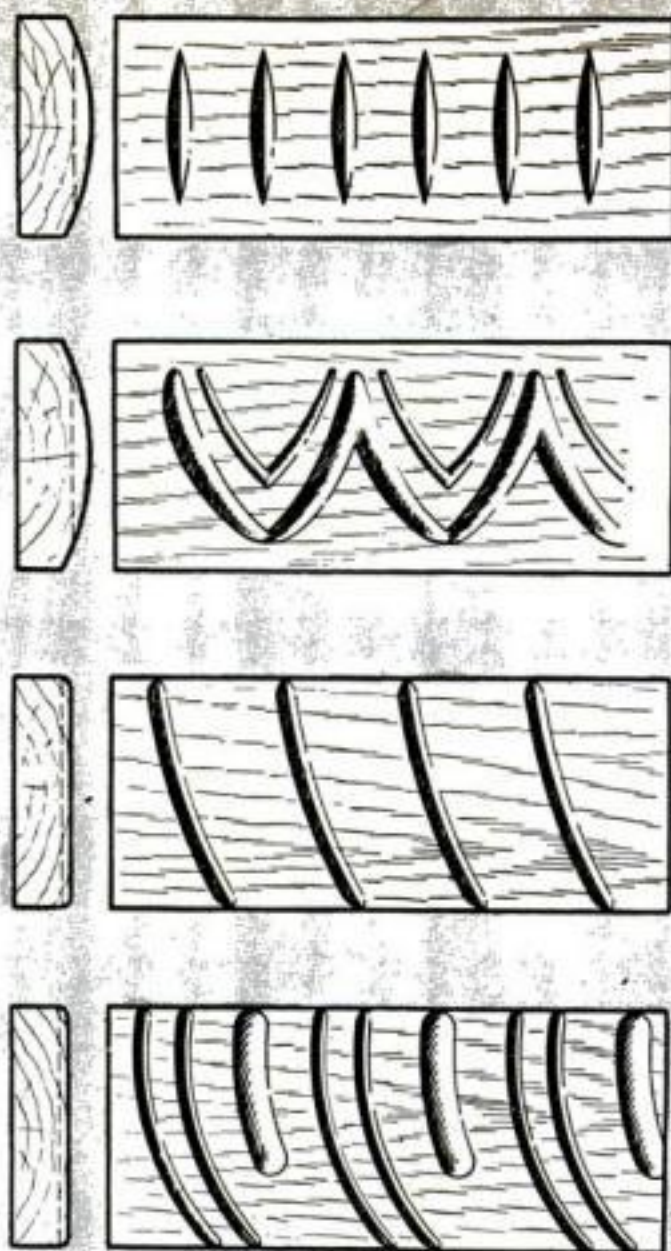


Delicate control of direction is maintained by thumb and finger, while constant depth is maintained by the mount. Rocking the mount slightly will vary the depth

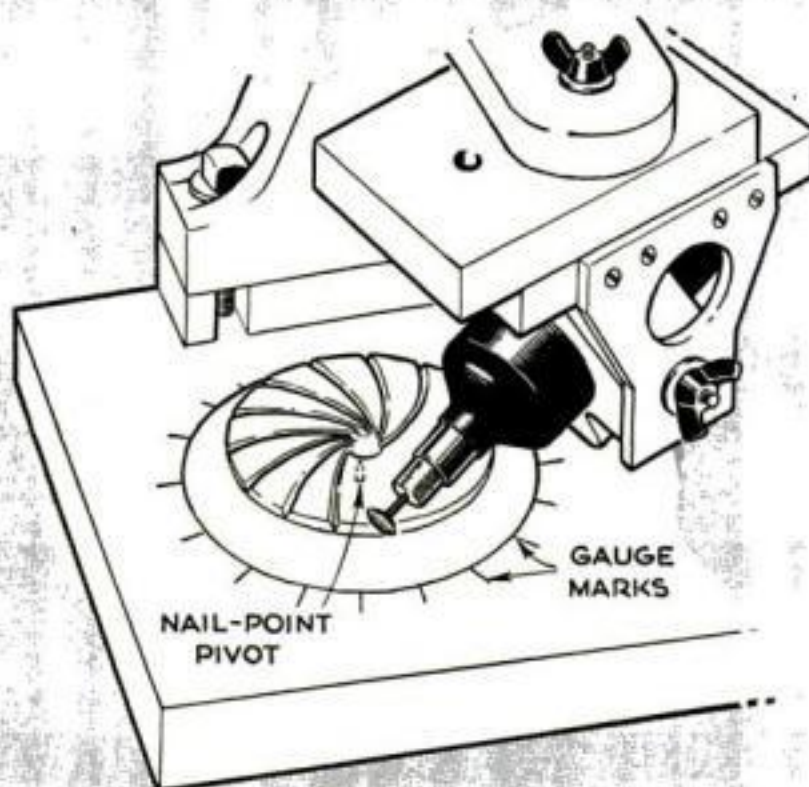


in a vise and round up the piece with a pear-shaped cutter. If the piece is bisymmetrical, one side can be carved first and then used as a guide for doing the other side.

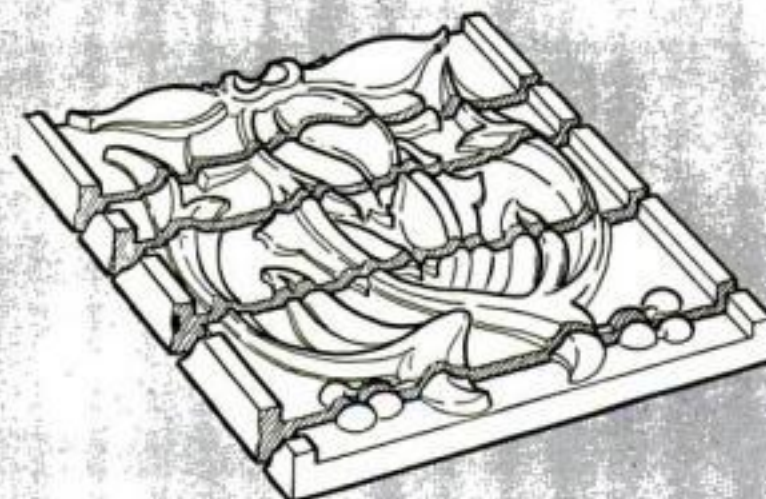
How can moldings be carved? Build a motor mount and jig similar to the one shown in the drawing on page HW 473. In this mount, the motor can be swung from side to side, its arc of movement depending upon which hole the pivot bolt is fastened in and the position of the swivel block on the sole of the motor mount. The position of the fence governs the direction of the cut. The chord of the carving curve is at right angles across



SAMPLES OF MOLDINGS CARVED WITH A JIG



SETUPS FOR CARVING ROSETTES AND MOLDINGS



BAS-RELIEF CARVING
(SECTIONS ILLUSTRATE CURVE PROFILES)

the molding when the lengthwise center line of the molding is directly under the pivot center. First make a starting cut; then move the molding forward the desired distance and mark the position of the first cut on the fence. Thereafter, each succeeding cut is moved to the mark and spacing is accurately maintained. The variety of molding carvings possible with this setup is practically unlimited.

Rosettes are carved with this jig by pivoting the blank on a sharpened nail set from underneath into the center of the blank. Radial lines can be brought to the center or else stopped short of the center to form a button.

Can polishing be done with small motors? Sanding drums are available for smoothing wood or plastic, and screw mandrels will hold small sanding and fiber disks and wire brushes. Felt wheels can be used with such

polishing agents as tripoli and rouge. Rubber wheels of various shapes, impregnated with special compounds, are useful for removing fine scratches, as well as for polishing small metal and plastic parts.

How is grinding done? A large variety of abrasive wheels may be had for light grinding of surfaces. Such grinding is especially valuable on hardened steel that cannot be filed, and for working in corners and cavities impossible to reach with larger tools. Use light pressure with abrasive wheels, because if the motor slows appreciably, the wheels glaze, wear rapidly, and may mar the work.

Grinding wheels are made of different abrasives suitable for the particular kind of material to be ground. Ordinary aluminum oxide wheels are suitable for average grinding. Silicon carbide is used for materials of low tensile strength, and a pure aluminum oxide for such materials as high-speed steel.

Comical Figure of Baker Tops Off Novel Bread Server

GUESTS will smile when served with bread from this tray, for a jolly little baker stands guard on top of the stack.

Turn the base from a $9\frac{1}{4}$ " maple or birch disk to the section shown. A felt disk cemented to the bottom will hide the holes left by the faceplate screws.

Draw the baker on $\frac{1}{2}$ " squares and jigsaw him from $\frac{3}{4}$ " stock. Insert a bit of $\frac{1}{4}$ " dowel for the nose. Color the face pink, the apron, cap, and collar white, the shirt blue, and the hair brown.

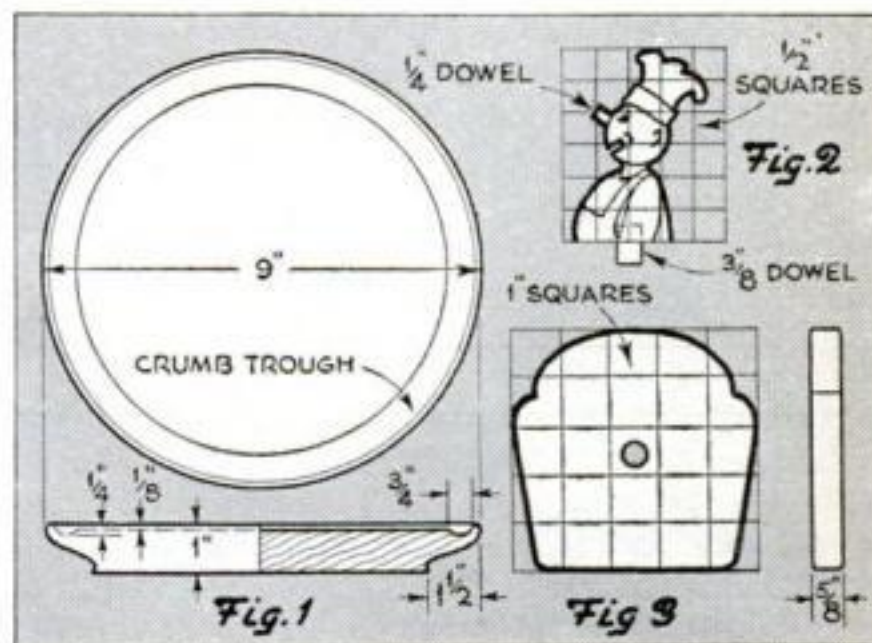
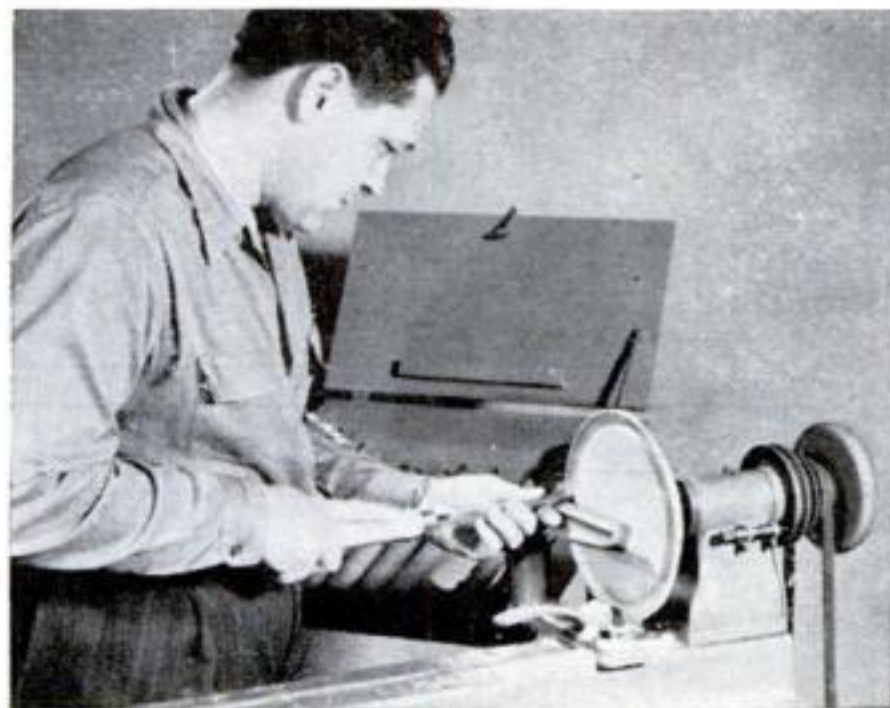
Cut the top from $\frac{5}{8}$ " stock. Paint the top surface white and the edges brown. To simulate bread texture, use a mallet to pound a piece of No. 2 sandpaper on the top after the paint dries. Brush off any loose paint.

Finish the turned tray and the underside of the top with clear lacquer or varnish.—FRANK HEGEMEYER.



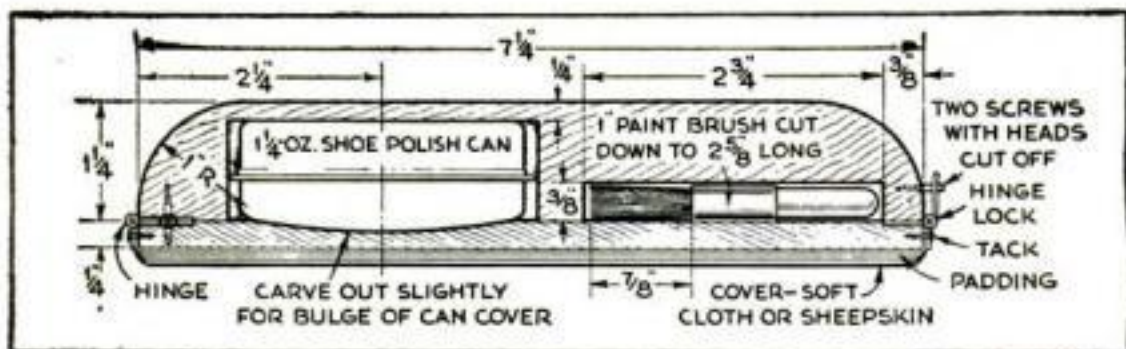
Lift the little baker and the top slice comes off, for it is actually a piece of wood that prevents the stack of fresh bread beneath from drying out

At left, turning the crumb trough on the lathe. Transfer the jigsaw patterns by means of squares





Polish, dauber, and cloth "shine brush" are all contained in this neatly carved and hinged shoe kit designed for service men



★ ★ ★ ★ Compact Shining Kit Serves Service Men

SELECTED by a committee of four service men as a prize winner in a Service Men's Gift Contest conducted by POPULAR SCIENCE MONTHLY, this kit for shining shoes rightly lays claim to its ability to serve well.

The entire outfit is contained within a carved and hinged case measuring $1\frac{5}{8}$ " by $2\frac{1}{4}$ " by $7\frac{1}{2}$ ". One hinged half is shaped along the edges to fit the fingers; the other is left flat and is padded and covered with velvet or a piece of sheepskin with the wool outside to be used in shining. The unpadded section is carved inside to fit a dauber made from a 1" paint brush cut down to a total length of $2\frac{5}{8}$ ".

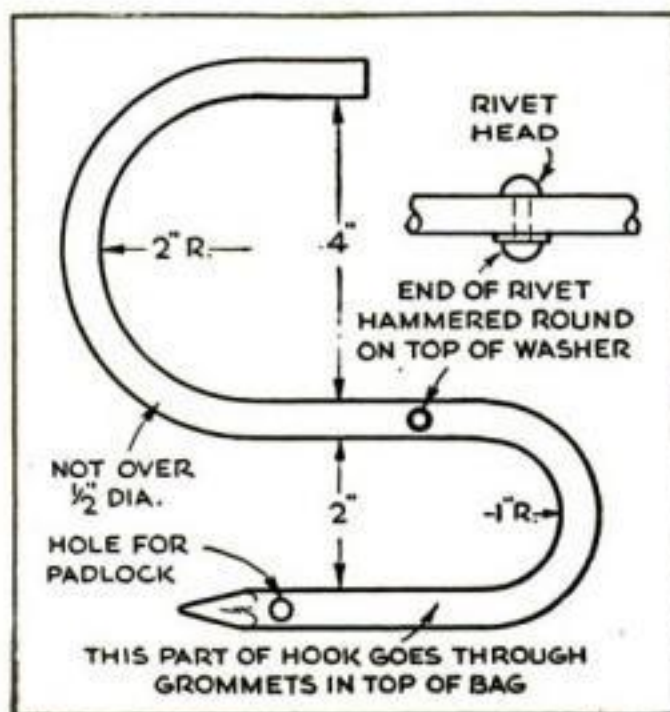
A can of shoe polish fits into a carved recess of the lower section; it is allowed to protrude slightly at the sides. The curved top of the can fits neatly into a shallow recess which has been formed in the upper section of the kit.—AXEL E. OGREN.

S-Shaped Metal Hook Locks Sea Bag and Acts as Handle

A SAILOR'S sea bag needs to be closed, locked, and carried just as does any other type of hand baggage. The device illustrated at the right does the complete job and, for that reason, was also one of the prize winners in the Service Men's Gift Contest.

The lower end of the hook is rounded to a dull point for ease in threading through the grommets on the top of the sea bag. A hole is drilled through the hook to take a padlock that prevents the grommets from slipping over the end of the hook.

A roundhead rivet is fastened in a hole through the hook, as shown in the drawing, to keep the grommets from slipping past that point to the rest of the hook. When the lower portion of the hook is threaded through the grommets and locked, the upper part is the handle.—HARRY LIEBERMAN.



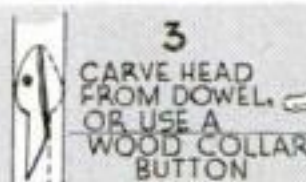
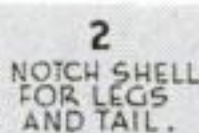
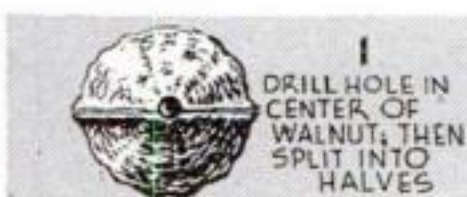
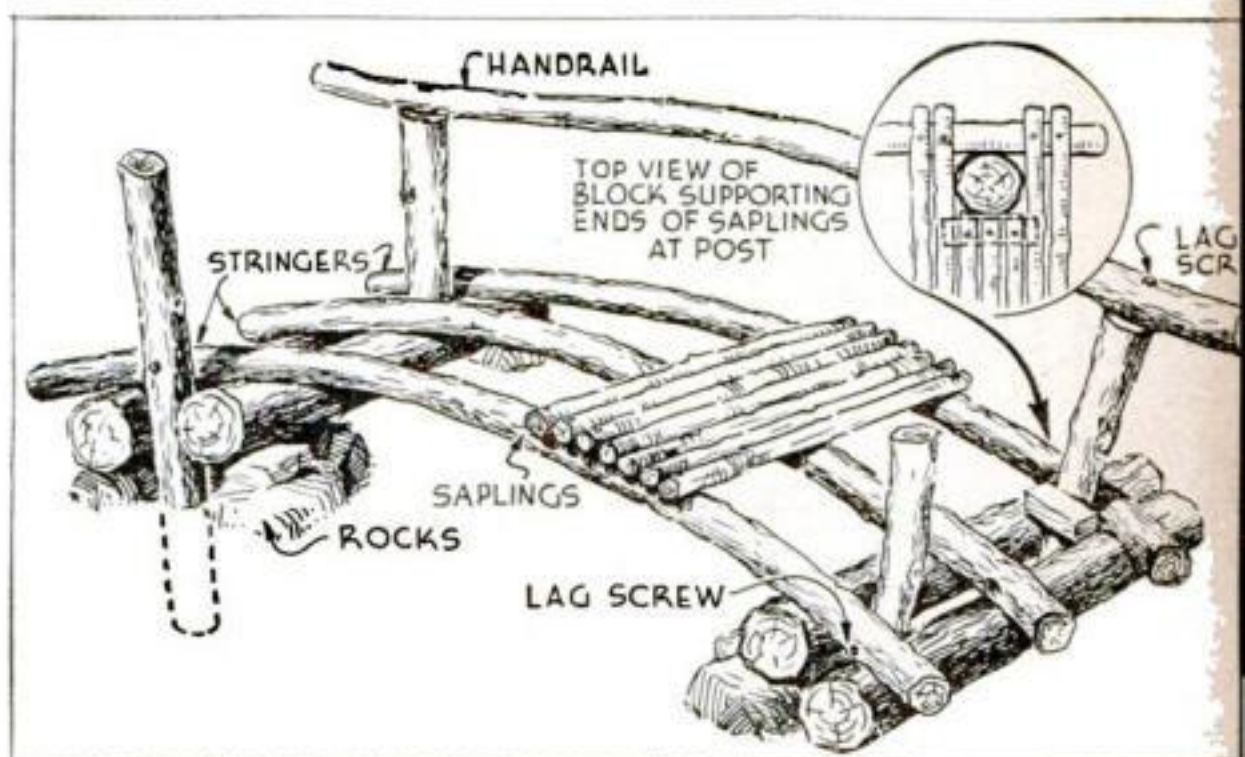


Rustic Garden Bridge Built from Small Logs and Saplings

A PICTURESQUE little bridge for an informal garden can easily be made of small logs and saplings. After selecting the spot for your bridge, brace the end posts with logs and rocks as suggested in the sketch. All the wood should be peeled and seasoned. Creosote the bottom ends of the posts and set them 24" into the ground. The rocks and cross logs hold them steady and add to the rustic effect of the bridge. Trim the arched stringers along their tops with an adze so that they will more readily support the floor.

The height of the handrails is about 24", while the width and length of the bridge is, of course, determined by the location chosen for it. Lag screws are used to hold logs and stringers in place.

It is best to drill the saplings which make up the floor of the bridge before attempting to nail them to the stringers.—H. S.



Walnut Shells Form Sprightly Turtles

AN INTERESTING and decorative novelty is a set of turtles varying in sizes and shapes. They are made of walnut shells, pipe cleaners, and short lengths of dowel. The shell is grooved with a rattail file for the legs, head, and tail. Legs are bent from pipe cleaners to the approximate shape shown, the length depending upon the size of the shell. A short length of the same material, bent to a hook shape inside the shell for firmer support, makes the tail.

The turtle's head is whittled from a piece of dowel. Cement all the parts into place, the head being tilted at a slight upward angle, and the legs bent to raise the body $\frac{1}{4}$ ". Cut a piece of cardboard to shape to seal the bottom of the shell.—EDWIN DREWITZ.

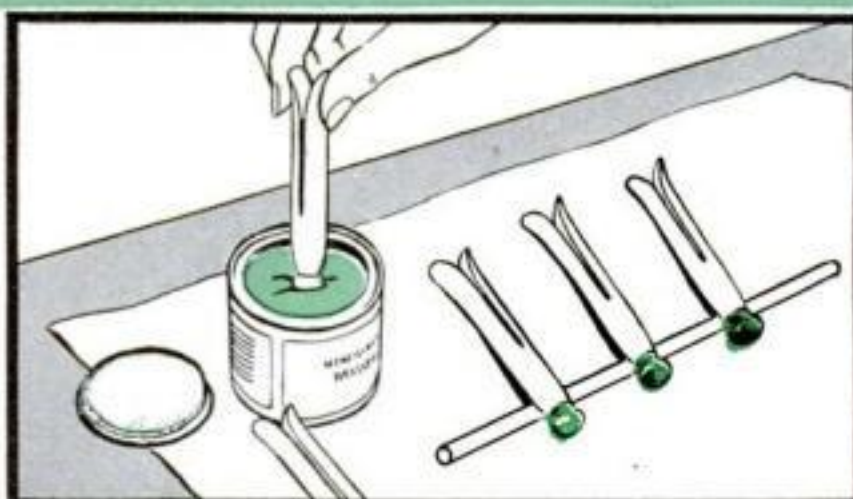
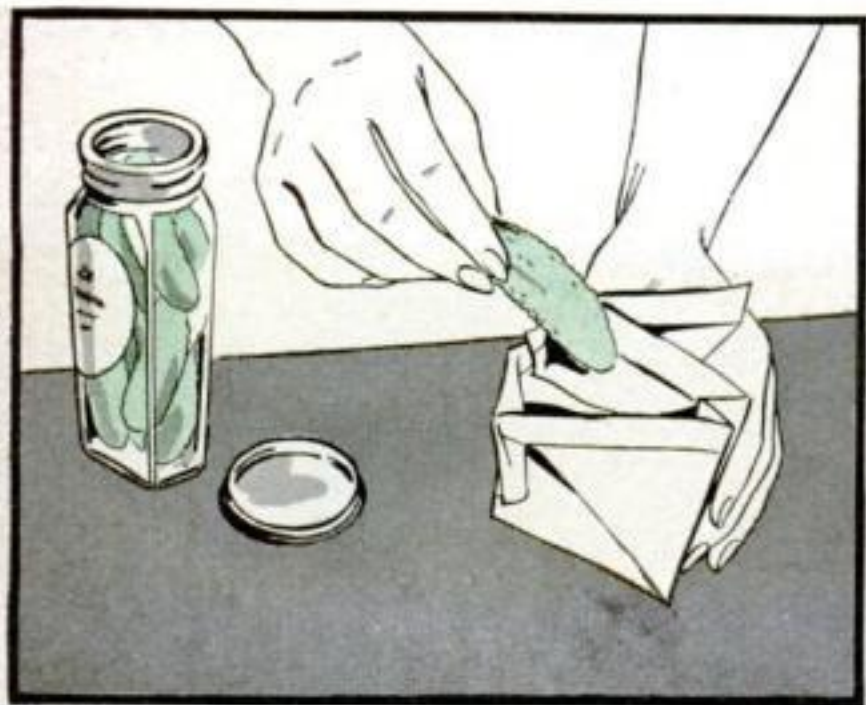


KEEPING THE HOME



If a small gas leak on a stove or hot plate occurs at the valve, simply place a drop of light oil on the moving part of the valve. This forms a seal between the tapered plug and its seat. Do not use oil on a tank-gas stove without first checking to be sure it will cause no reaction with this gas.

Heavy waxed-paper folding bags in which gelatin powder is sold make ideal leakproof containers for lunch-box pickles. Since the liquid does not evaporate, pickles remain fresh. Use of these bags for any juicy food stops the leakages that may flavor or make soggy the lunch-box contents.



Clothespins that are used to hold dyed materials may transfer the stains to white clothes. If the heads of some pins are dipped in brightly colored enamel, they can easily be set apart for use with dyed wash. Colors also help prevent loss of pins.



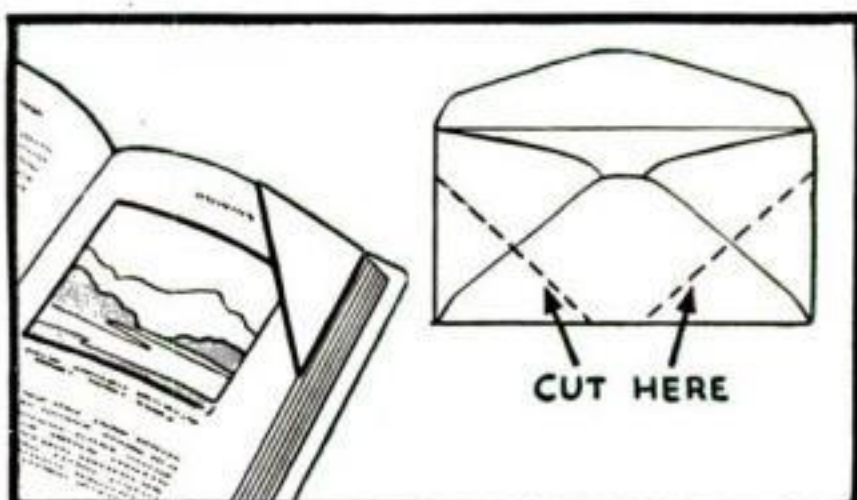
Pulling out threads when ripping machine stitching is tedious as well as a strain on your finger tips. A pair of household tweezers will allow you to do this with no fatigue and in a fraction of the time.

Knitting yarn that is to be stored for any length of time may be kept safe from moths by using old tobacco containers. The faint odor repels moths and does not damage yarn.



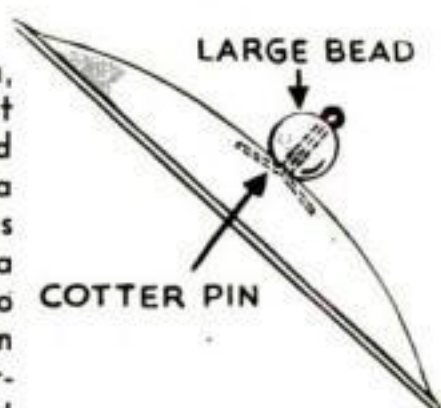
Wooden buttons may be protected from grime with a coat or two of colorless nail polish. This polish forms a hard lacquer finish that does not modify the underlying color of the buttons. Painting is done by using the applicator on the bottle cap.





Useful bookmarks can be easily made by cutting the corners off old envelopes. Such a bookmark can be slipped over a group of pages to block off obsolete data in reference books or catalogues. A strip of cellulose tape will help keep it on

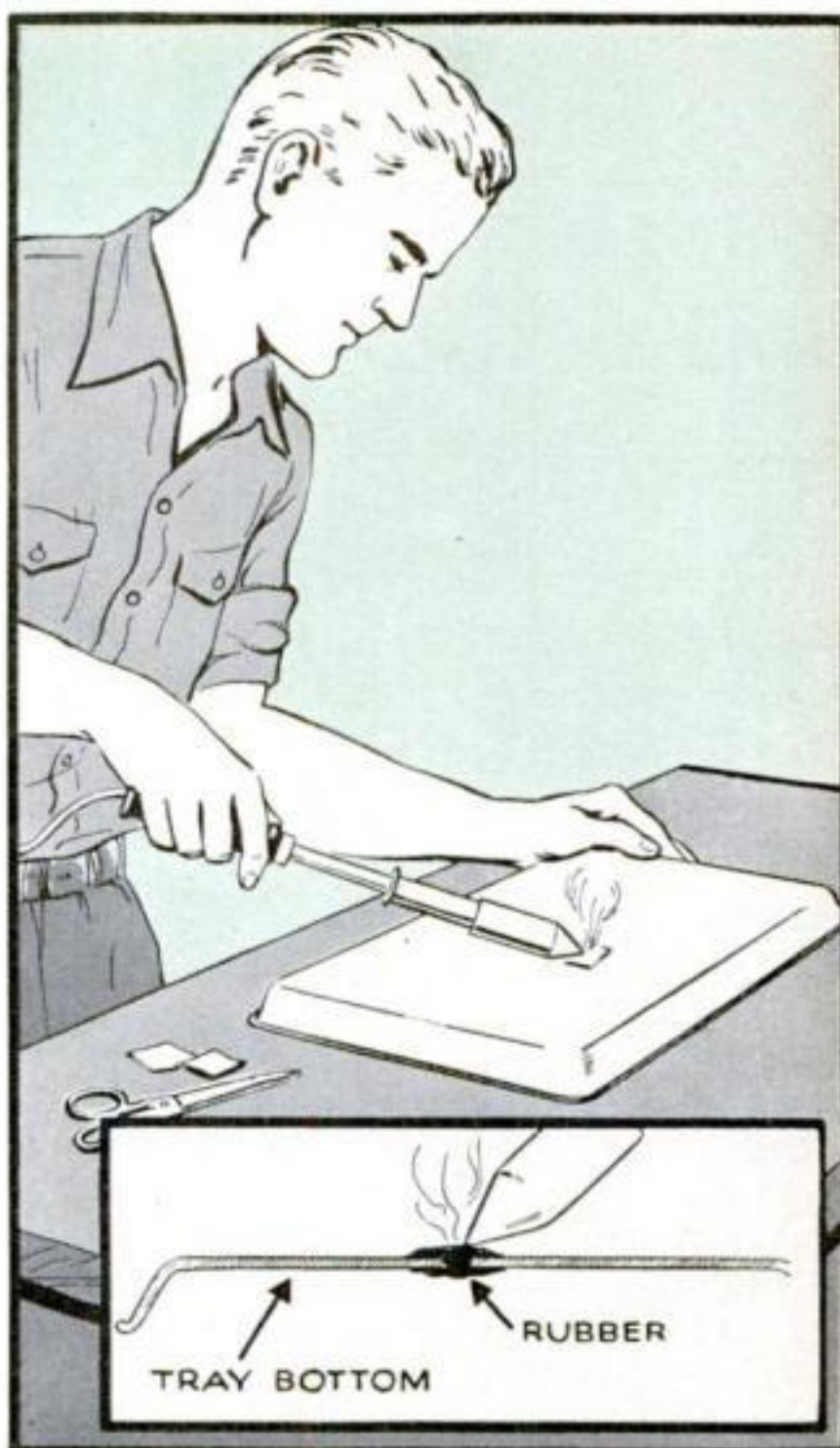
If used in the oven, wooden knobs on pot covers will char and break off. Here is a repair that resists oven heat: Fasten a large glass bead to a pot lid, as shown at right, using a cotter pin to hold it



Common door locks can be made tamperproof with a length of stiff wire. If inserted through the key and hooked over the knob as shown, the wire keeps marauders from turning the key and pushing it through inside

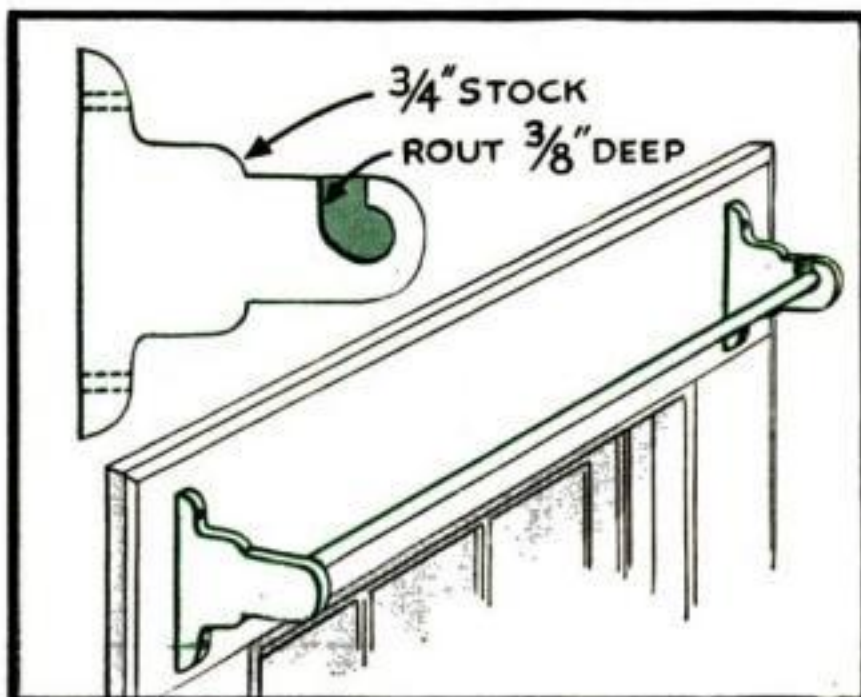
HEAVY WIRE HOOK

If an electric plug is hard to pull out, rub both sides of the prongs with a soft-lead pencil. The graphite deposited on the contacts lubricates the parts and permits them to slide in and out easily. Carefully straighten prongs that are misaligned



Holes in hard-rubber articles such as photo trays can be "soldered" with inner-tube patching rubber. Cut it $\frac{1}{4}$ " larger than the hole and melt it on the area, using an ordinary soldering iron. It will adhere tightly on a dry surface free of oil and rust. Talcum will neutralize surface tackiness

A satisfactory replacement for metal curtain rods and brackets can be made through the use of wood. Saw the brackets from $\frac{3}{4}$ " stock and rout a curved recess in each bracket in order to hold the dowel that serves as the rod. Fasten with wood screws to the casing and finish to match the woodwork



SLIDING-DOOR WARDROBE DESIGNED FOR A CHILD'S ROOM



Bette Joan's wardrobe is just like a grownup's except that there are no hinged doors that might pinch her tiny fingers

AS FUNCTIONAL as it is good looking, this wardrobe cabinet will do much to teach a child the fundamentals of neatness. A special feature of it is the door, which slides upward into the top of the cabinet and cannot pinch little fingers. It is also an advantage where space is limited, since it does not swing out into the room.

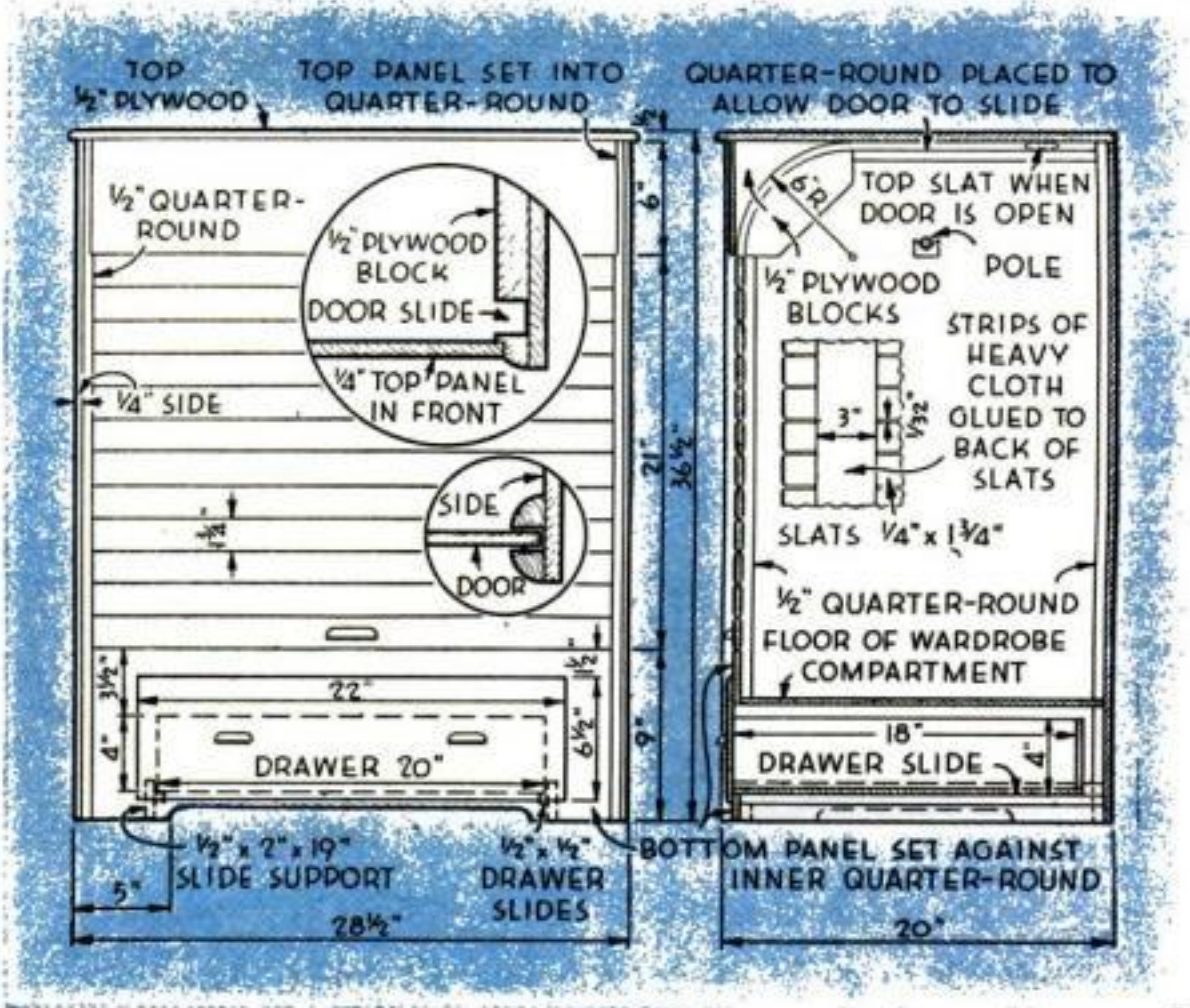
Dimensions given in the drawing below can be varied according to the size and age of the child. The body of the wardrobe shown was made of $\frac{1}{4}$ " plywood, flathead screws being driven through from the outside edges into quarter-round moldings at all the joints. All screws were slightly counter-sunk and the holes filled before finishing. The top was made of $\frac{1}{2}$ " plywood so that it would not bend under the weight of any heavy object placed on it and bind the door.

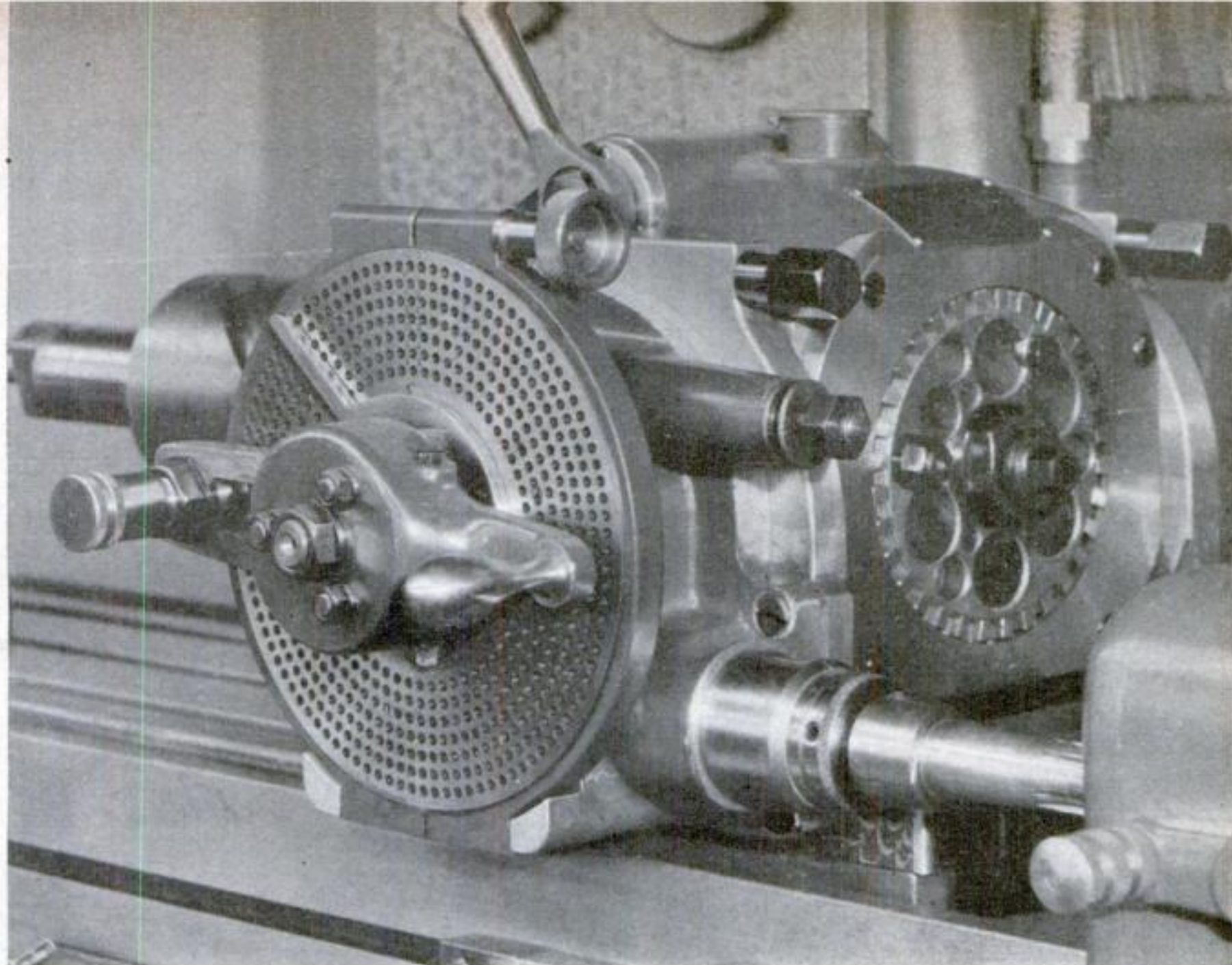
Slats for the door were cut from straight unwarped lattice material, rounded on all edges and corners, and sanded down smooth. They were then laid out on a level surface and weighted down with their edges not quite touching each other. Four strips of heavy cloth glued to the back hold them together.

Be sure the door groove is smooth and wide enough to allow

for easy movement. A coating of ordinary floor wax will make for free action. The drawer operates on two $\frac{1}{2}$ " square slides screwed to supports fastened between the front bottom panel and the back of the wardrobe.

Finish the cabinet and decorate it as desired. The child's name cut from $\frac{1}{4}$ " plywood and glued to the top front panel will add a pleasing personal touch.—JACK GOSS.





HOW TO SET UP WORK ON A DIVIDING HEAD

FREQUENTLY the machinist must divide a circle into several parts, as in making a gear, reamer, jig, milling cutter, or similar part on which must be spaced teeth, cutting edges, or holes. Such work is usually done with a dividing head, an accessory mounted on the table of the milling machine that rotates the work through given angles to produce the number of divisions desired.

A dividing head consists of an indexing plate in which are several circles of evenly spaced holes, a crank with a pin that fits into these holes, and gearing that connects the crank to a spindle in a definite ratio, usually 1 to 40. Since the work is mounted on the spindle, one turn of the crank will rotate it $1/40$ turn. To cut a 20-tooth gear, for example, the crank would be given two full turns after each cut to locate the next tooth. Thus 40 divided by the number of divisions required gives the number of turns or the fractional part of a turn to be made by the index crank each time.

When this formula does not yield a whole number of turns, but involves a fraction of a turn, the several circles of holes come into full play. A circle is used having a number of holes divisible by the number of divisions

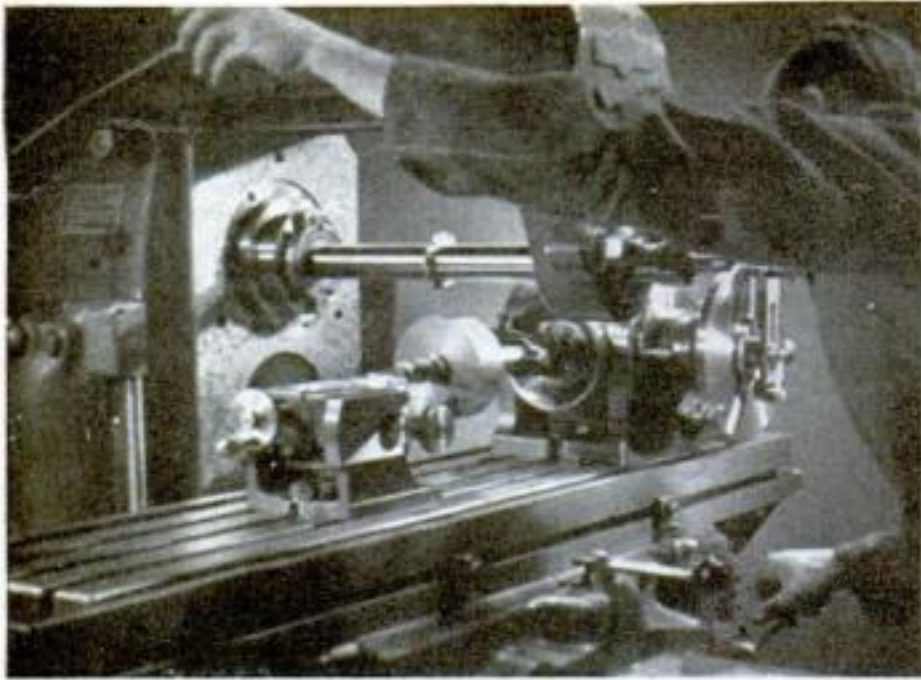
required. Thus, counting off 11 holes on the 66-hole circle enables the operator to turn the crank exactly $1/6$ turn.

Besides the plain dividing head, which has a spindle that rotates about a horizontal axis, there is the universal dividing head, the spindle of which can be tilted vertically to rotate at various angles, and the helical dividing head. The spindle of the latter can be connected to the lead screw of the milling-machine table, so that the work may be rotated in a fixed ratio to the table movement for milling the flutes of twist drills and the like.

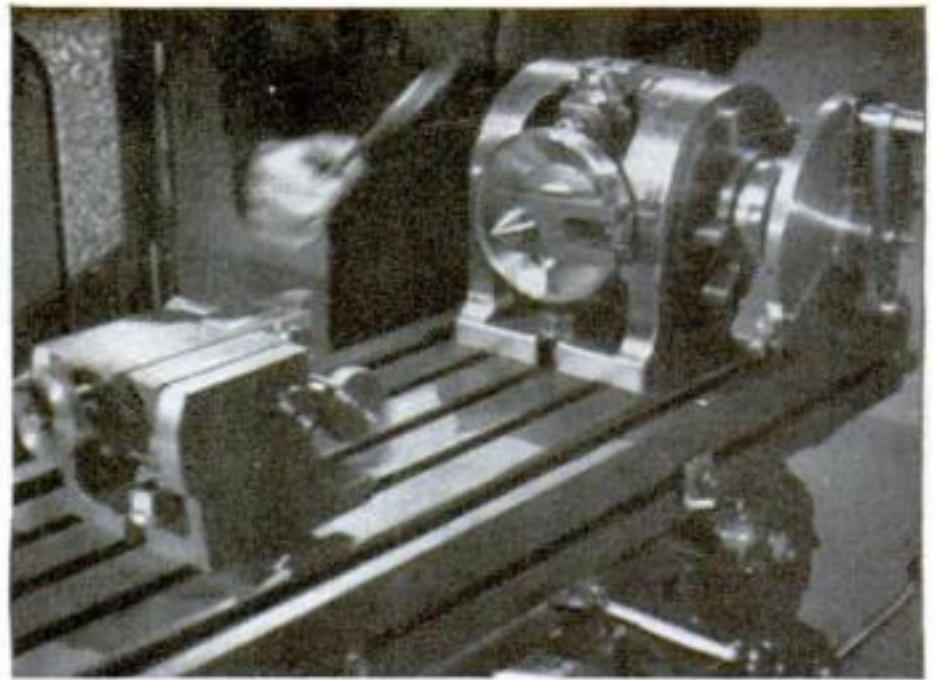
Photographs on the following pages show how a typical job—a blank for a 36-tooth gear—is set up, and how the dividing head is used to space the teeth correctly. These photographs were made from a sound film prepared by the U. S. Office of Education and distributed by Castle Films for training war machinists in school and shop classes.

MACHINISTS FOR WAR WORK





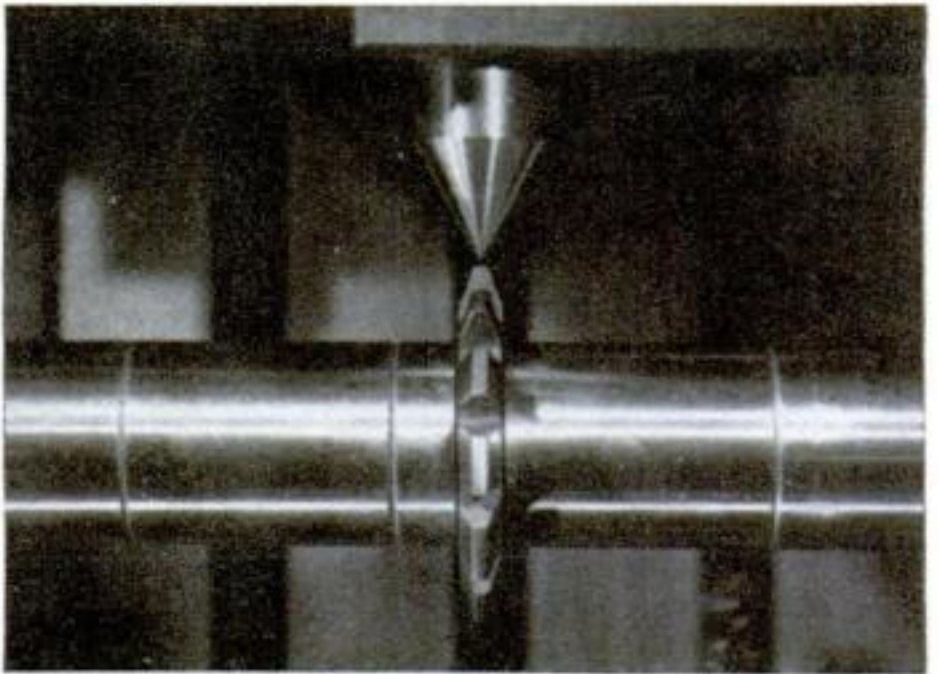
1 Above is a typical setup involving the use of a dividing head. A 36-tooth gear is to be milled from a machined blank. The various steps in setting up the work are explained in the photos that follow



2 Both the dividing head and its tailstock are bolted to the center slot of the table, which is run in close to the column to permit mounting the cutter on a short arbor for maximum rigidity



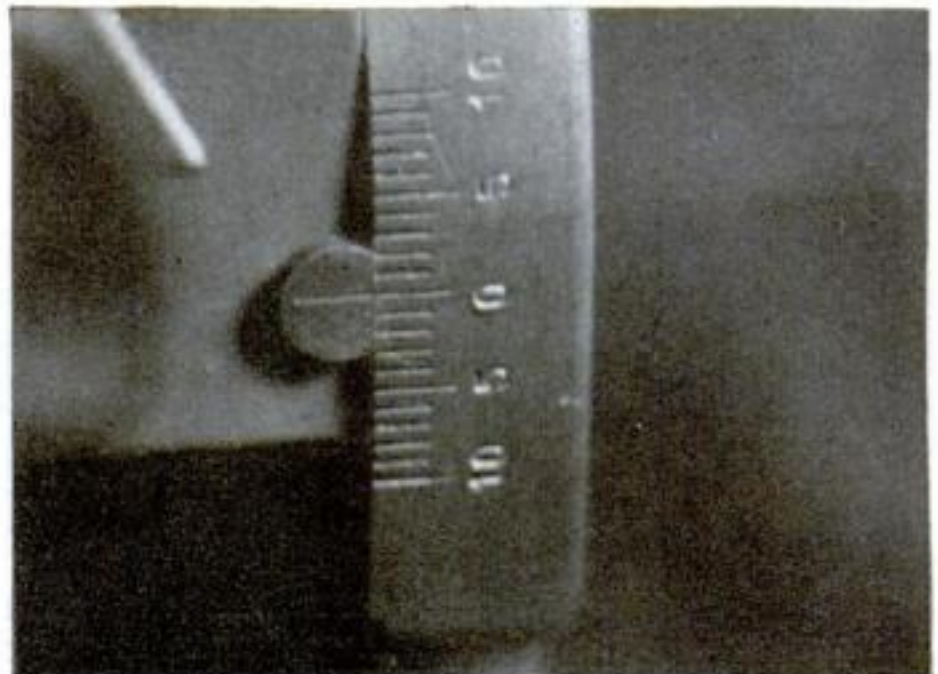
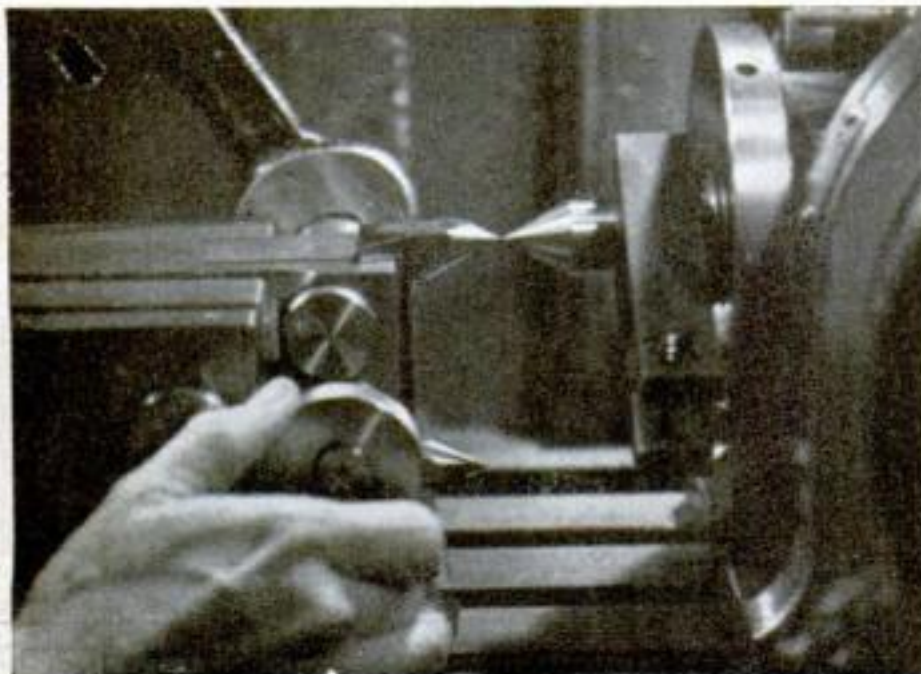
3 A handbook specifies a No. 3 cutter for gears of from 35 to 54 teeth. Arbor collars used in mounting it must be scrupulously clean; dirt will throw it out of alignment. The cutter is keyed fast

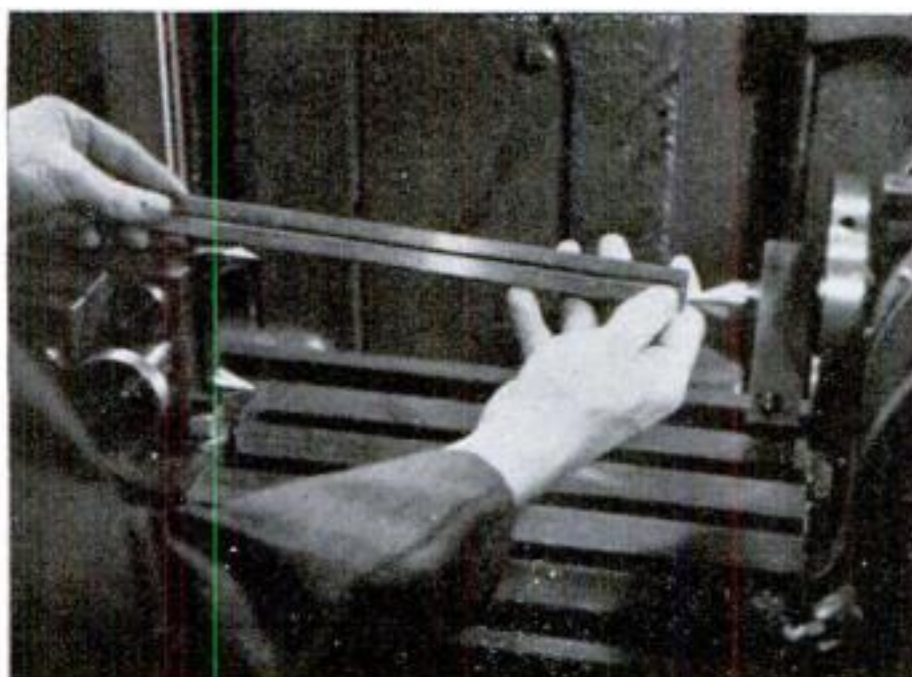


4 With the overarm and outer arbor support locked, the table is traversed until the dividing-head center coincides with a center line on the cutter teeth, and the traverse is locked in this position

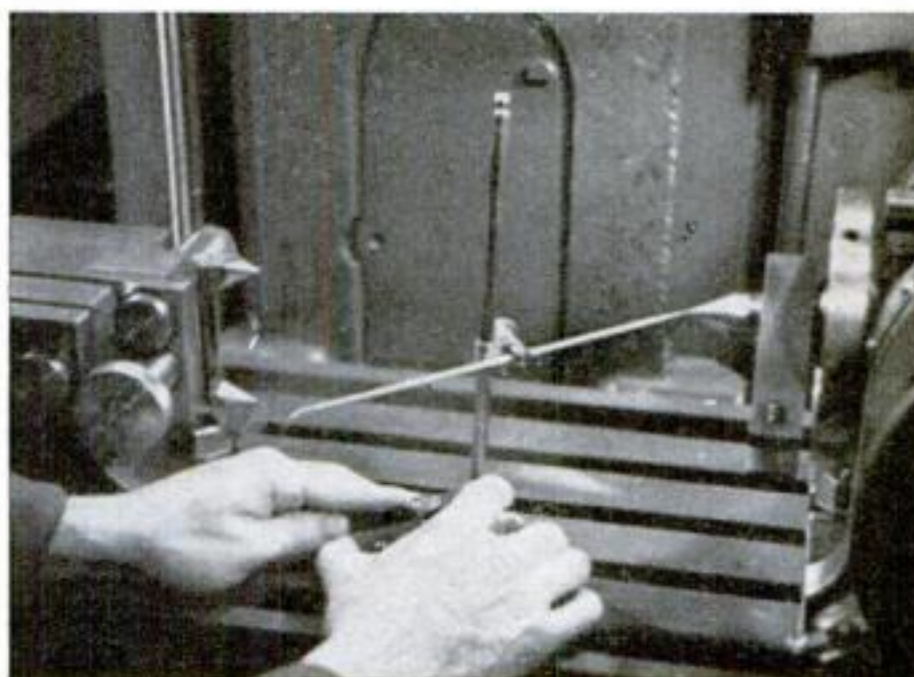
5 To cut teeth of uniform depth from end to end, the gear blank must be parallel to the table. Therefore the tailstock center must be adjusted to exactly the same height as the headstock center

6 As spur-gear teeth must be cut parallel to the gear axis, the work mandrel must be parallel to the table feed. Hence both centers are aligned horizontally to a zero mark on the tailstock scale

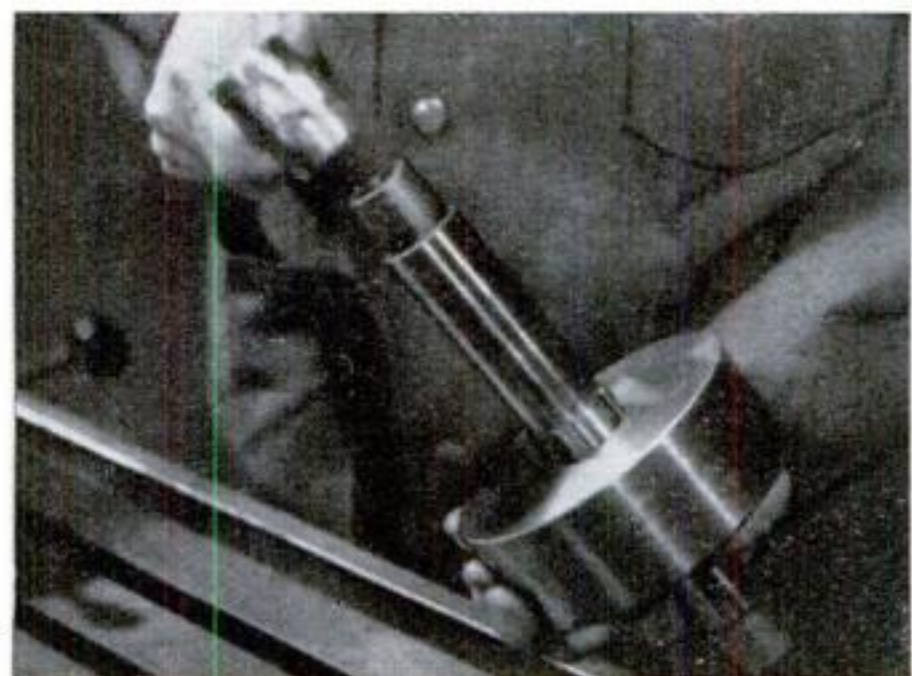




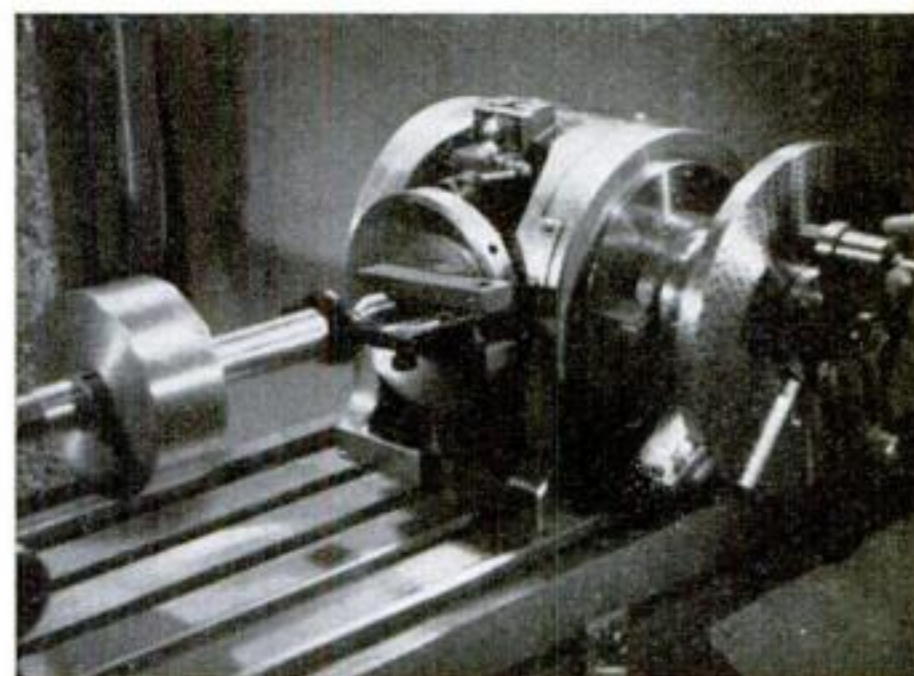
7 The tailstock is backed off a distance equal to the length of the mandrel and bolted fast. Its center can be advanced or retracted like that of a lathe tailstock to permit inserting the work



8 Rebolting the tailstock tighter or looser than it was in its first position may affect its vertical alignment. This is therefore rechecked against the headstock center with a surface gauge



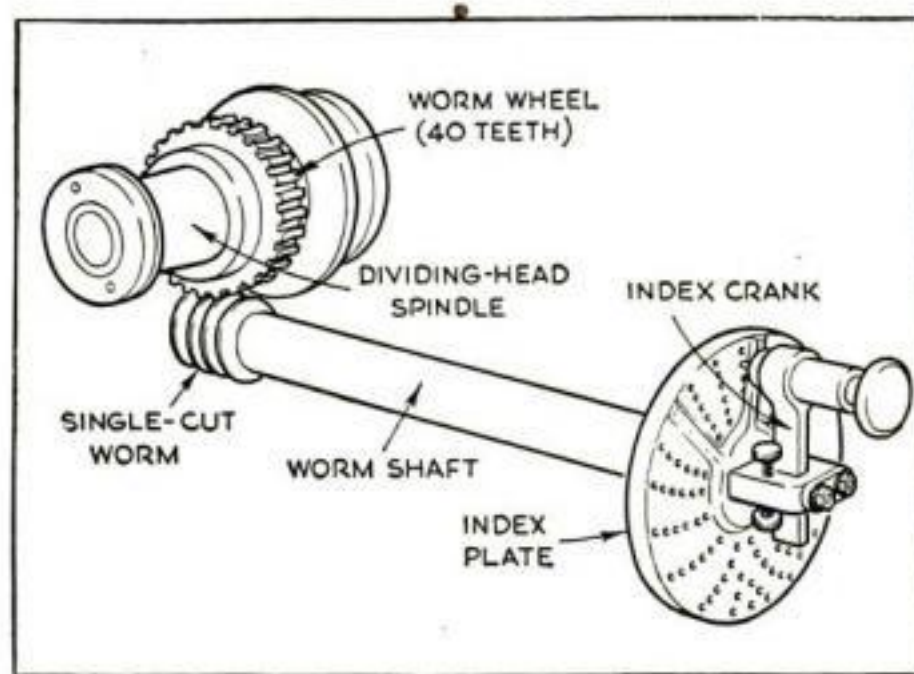
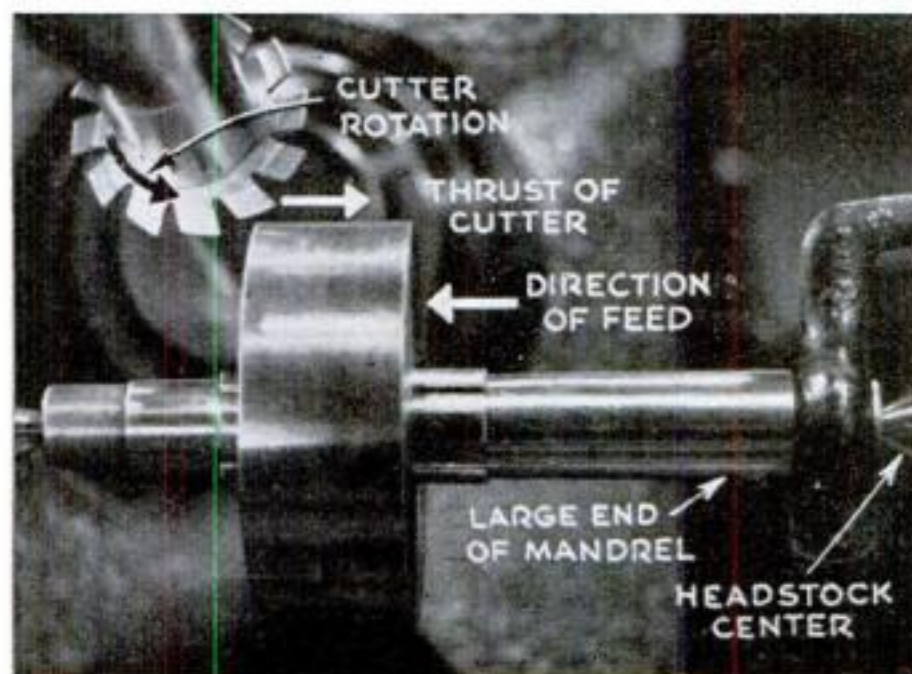
9 A splined sleeve, split lengthwise, is inserted and centered in the bore of the gear blank. As a tapered mandrel is driven into this with a lead hammer, the sleeve expands to grip the blank fast

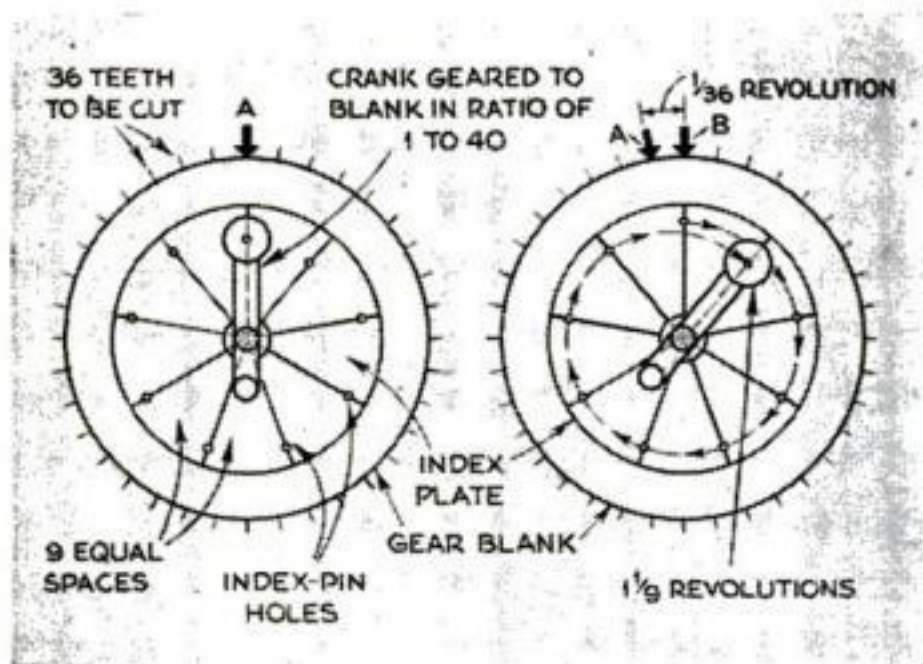


10 On the larger end of the mandrel, which goes toward the headstock, is bolted a dog. This is held tightly against the driver slot on the spindle by a setscrew to eliminate all backlash

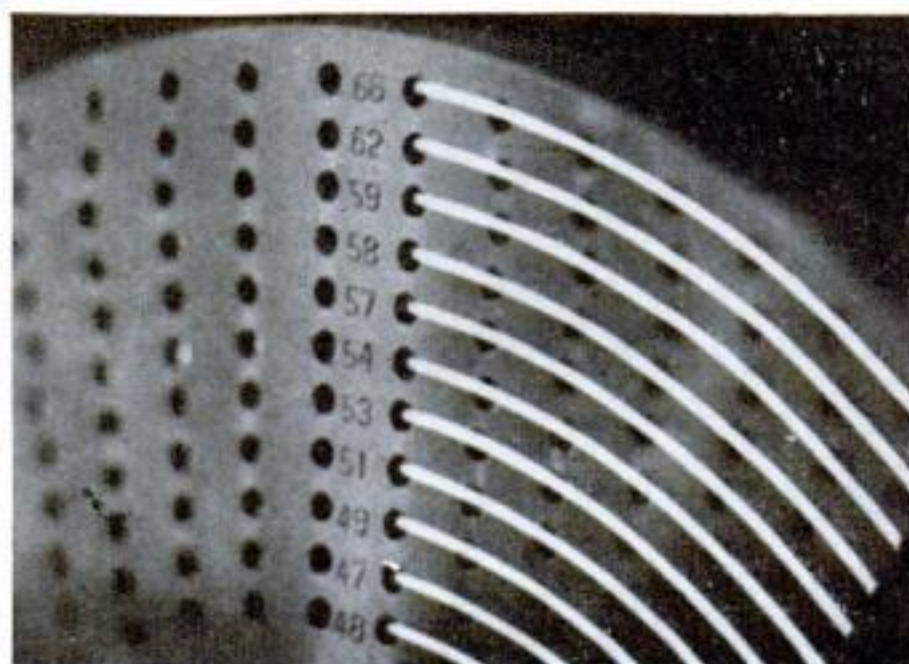
11 The thrust of the cutter, being toward the big end of the mandrel, will only wedge the work tighter. If the thrust were toward the small end, it would loosen the gear blank and spoil the job

12 As the gear ratio of the dividing head is 1 to 40, dividing 40 by the number of teeth to be cut—36—will give $1 \frac{1}{9}$ turns as the distance the crank must be rotated for each tooth (continued)

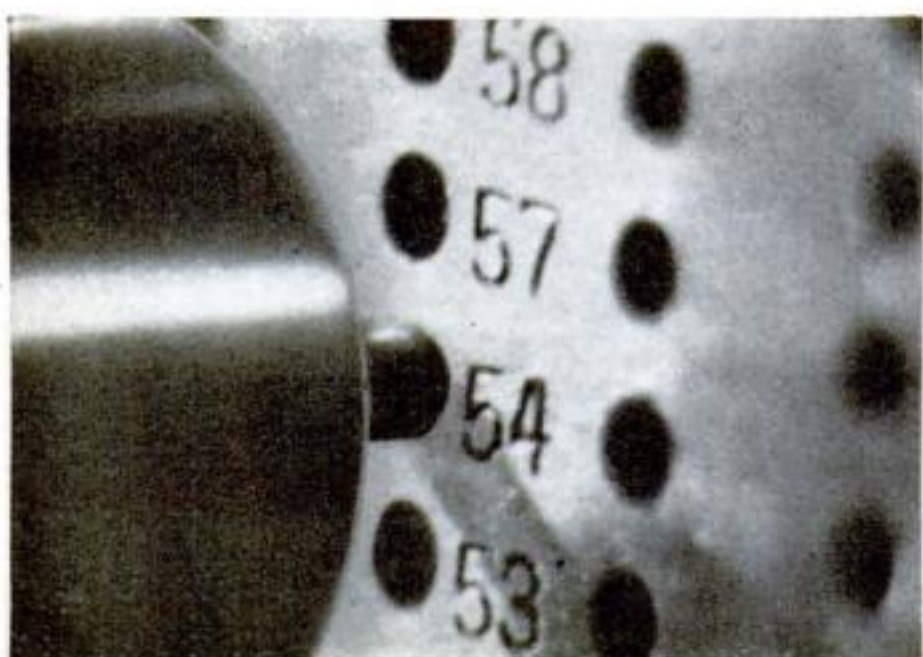




13 Our 36-tooth gear could be cut readily with a nine-space index plate, shown superimposed on the gear in the drawings above. After cutting tooth A as at the left, we would revolve the crank one complete turn plus one division to cut tooth B

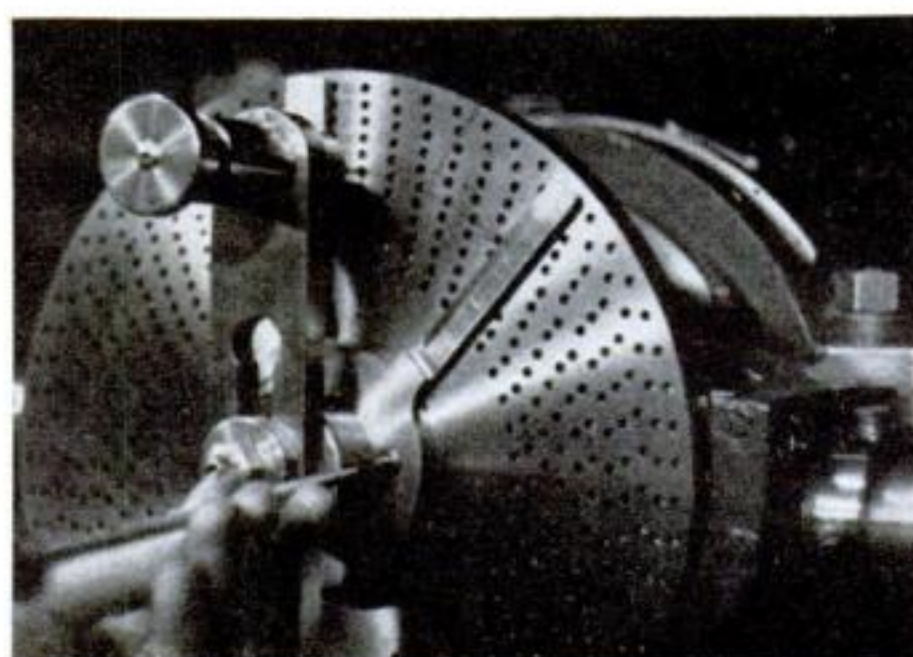


14 Instead of nine parts, the index plate has a series of circles on which various numbers of holes are evenly spaced. Each is marked with the number. The $1/9$ turn needed can be indexed on any circle having a number of holes divisible by nine



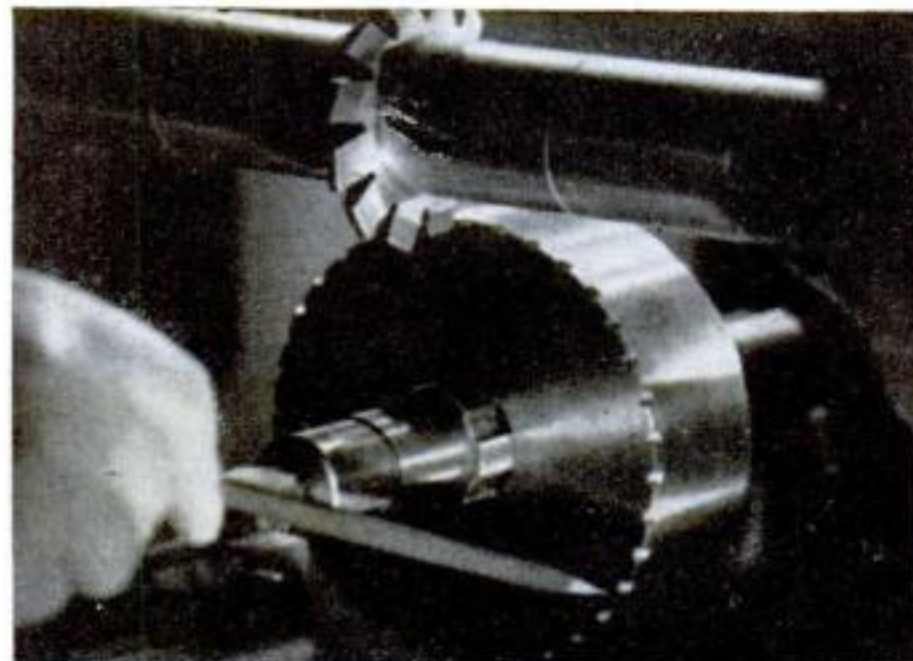
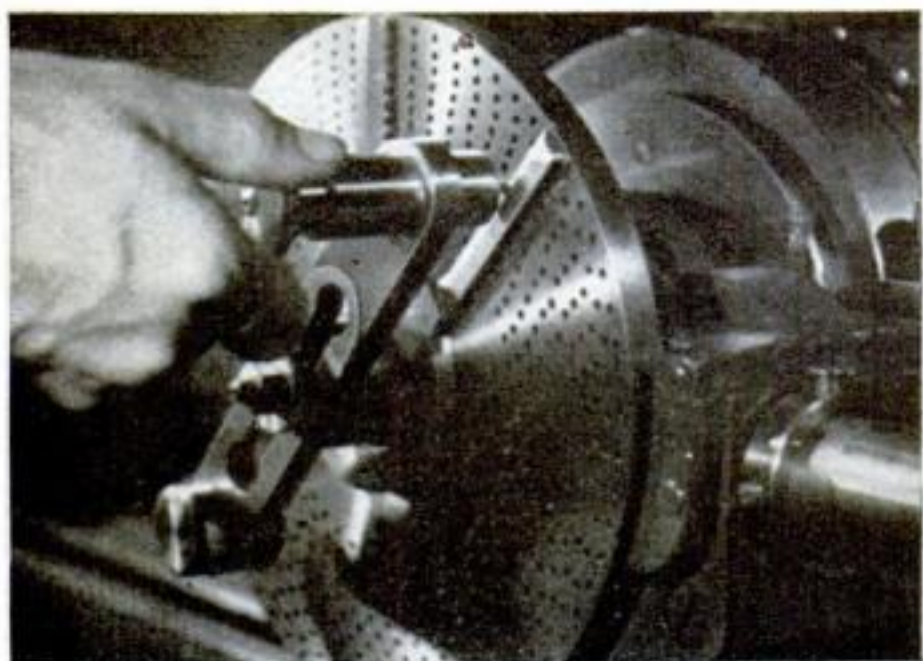
15 In this plate, it is the 54-hole circle that fulfills this condition. The crank handle is adjusted radially until its pin falls into a hole in this circle, and is then locked at this setting

17 Locked together, both arms can swivel about, always the same distance apart. As each tooth is cut, the crank is turned one revolution and far enough beyond to bring it against the second arm



16 Dividing 54 by nine gives six. One sector arm is therefore set up against the crankpin, and the other arm is set flush with the far edge of a hole six holes away, not counting the first hole

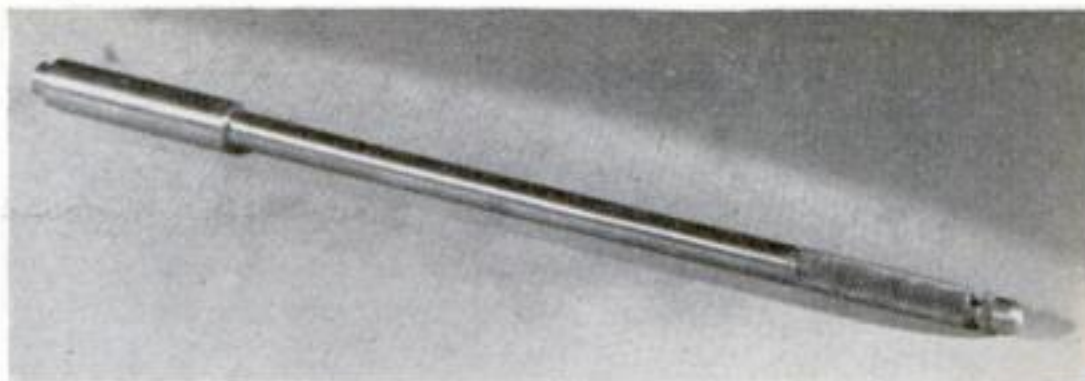
18 The sector is then swung down against the pin, ready for indexing the next tooth. All 36 cuts are very lightly nicked. If the first one indexes accurately the second time, the setup is correct



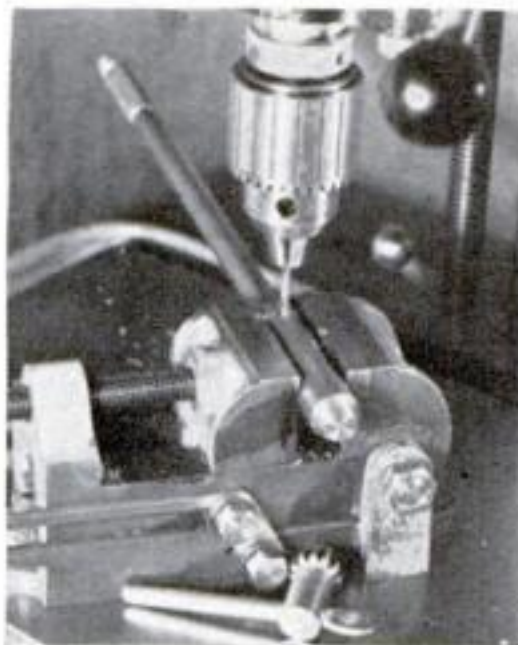
NEW SHOP IDEAS

A KNOCKOUT BAR for removing the headstock center from your lathe can be turned in the lathe from odd pieces of scrap steel. The drawing and photographs show a bar of a size useful for popular 9" and 10" lathes. The handle projects a few inches beyond the headstock and is knurled for an easy grip, with a turned ornament that adds to the appearance and provides a smooth, rounded end.

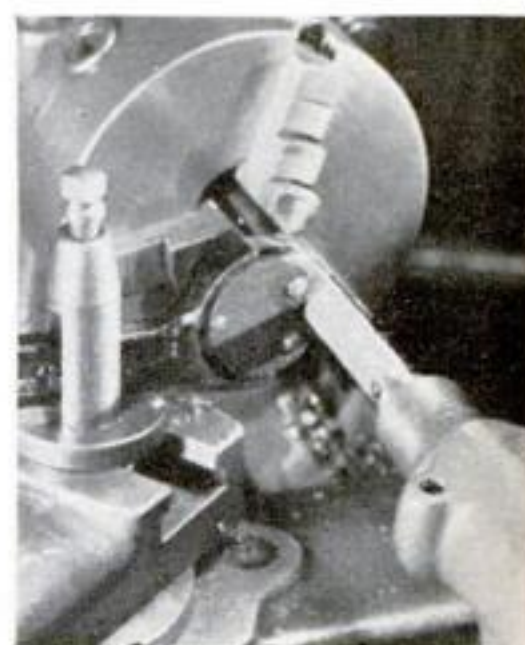
The bar is made in two parts, handle and bushing, with the bushing drilled for a tight fit on the handle and, after the two are assembled, drilled again across the diameter for a pin to hold the two pieces firmly together. The bushing is turned to size for an easy fit in the spindle, and a pin is turned on the end of the bushing. With this arrangement both the center and the reducing sleeve can be removed without damage. After the pin takes out the center, another tap causes the bushing to knock out the sleeve, if one is used. The tapered spindle should always be



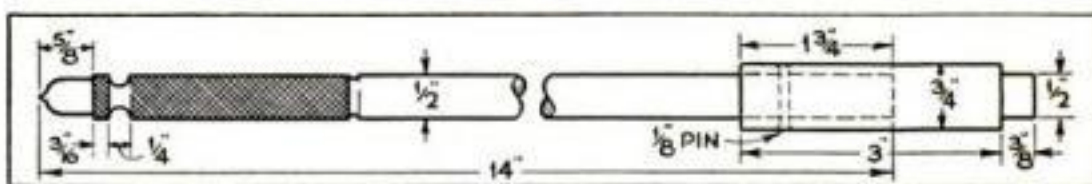
How the headstock-center knockout bar looks when assembled



Drilling the bushing and bar for a pin to lock them rigidly

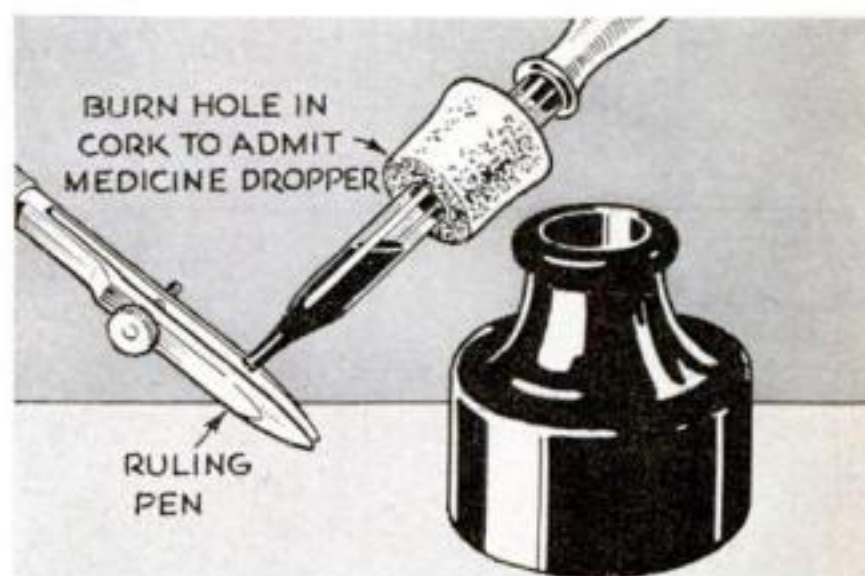
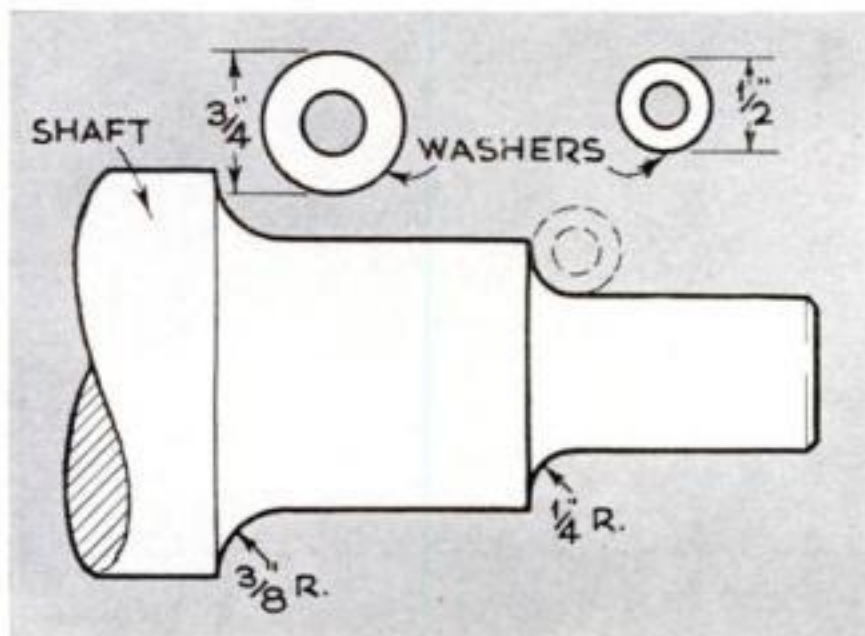


To knurl, chuck the work and steady it with the tailstock



All dimensions for the knockout bar are shown in the drawing

WASHERS AS RADIUS GAUGES solved one machinist's tool-priority problem. Unable to obtain a radius gauge, he turned washers to various sizes to gauge the radii of shaft fillets and other machined parts. For example, a radius of $\frac{1}{2}$ " can be gauged with a washer of 1" diameter.—RONALD EYRICH.



RULING PENS CAN BE FILLED from a medicine dropper with more accurate control over the amount of ink than the conventional quill allows. Mounted in a stopper cut to fit the bottle, the dropper can be pushed down as the ink level falls.—R. E.

Centering Work for

By C. W. WOODSON

ACCURATELY located and drilled center holes are required in both ends of work that is to be held between centers in the lathe. Precision in this respect is especially important when several pieces of the same kind are to be machined. These holes, which serve as bearing points for the lathe centers, may be laid out in any of several ways, and they can be drilled in the lathe itself if a centering machine is not available.

When several pieces are to be machined to identical dimensions with the same tool or carriage-stop settings, all the center holes must be drilled and countersunk to the same diameter. When the centerdrilled work is being mounted between the lathe centers, the countersunk holes must be kept free of dirt and chips to assure accurate centering, and the tailstock center must be oiled well to lessen friction.

There is no standard size for center holes, but judgment must be exercised in keeping them reasonably proportionate to the diameter of the work. The chart below will be a help in this direction. It gives several accepted dimensions for the drill, hole, and countersink that have proved to be satisfactory for work of various diameters. One dimension that must be followed precisely, however, is that of the angle of the countersink, which should be 60 deg. for a perfect fit with the lathe center.

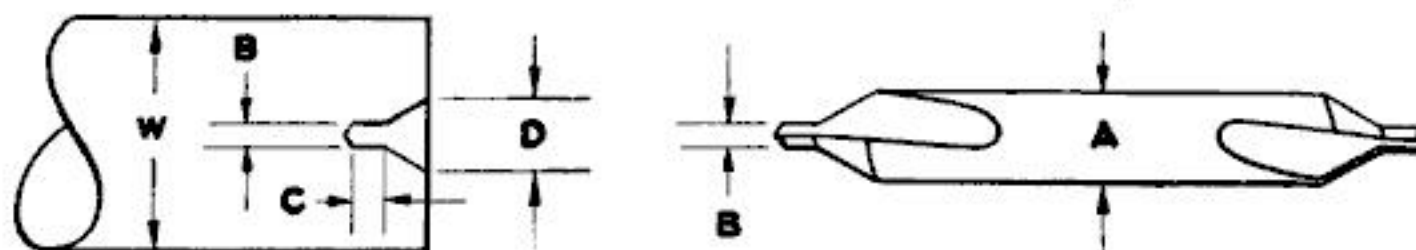
Center holes may be located quickly and accurately on round stock with a centerhead and scriber, following the method shown at A in the drawings at the upper right of the facing page. A mark is scribed along the side of the blade held against the end of the stock; then a quarter turn is made with the square, and another mark is scribed at right angles to the first. The intersection of these two lines will indicate the exact point for prick-punching and centerdrilling.

A quick and convenient method of locating the center of stock of any shape is with hermaphrodite calipers, as indicated at B in the drawings. The calipers can be set at half the diameter of the stock or slightly over or under that dimension. This will provide either a point of intersection that will be the center of the piece or several marks that will enclose the center point, as shown in the drawings.

In using a centerpunch, place it accurately on the center you have laid out, as at the left at C, and strike it a sharp blow with the hammer, driving it down far enough to make a hole that will permit the work to be lightly supported between the lathe centers. Revolve the piece in the lathe with one hand, testing for trueness with a piece of chalk. If the chalk marks show high spots, drifting with the centerpunch will draw the hole over to one side. This is done by placing the punch at an angle, as at the right at C, and driving it toward the high side of the

DIMENSIONS OF CENTER HOLES

[LATHE WORK]



DIAMETER OF WORK		DRILL AND COUNTERSINK DIMENSIONS			
FROM	TO	A	B	C	D
3/16"	7/32"	1/8"	3/64"	1/16"	5/64"
1/4"	11/32"	1/8"	3/64"	1/16"	3/32"
3/8"	17/32"	13/64"	1/16"	5/64"	1/8"
9/16"	25/32"	15/64"	5/64"	3/32"	3/16"
13/16"	1 3/32"	3/10"	3/32"	3/32"	1/4"
1 1/8"	1 15/32"	7/16"	5/32"	5/32"	5/16"
1 1/2"	1 31/32"	7/16"	5/32"	5/32"	3/8"
2"	2 31/32"	1/2"	7/32"	3/16"	7/16"
3"	3 31/32"	5/8"	7/32"	7/32"	1/2"
4"	And Over	5/8"	7/32"	7/32"	9/16"

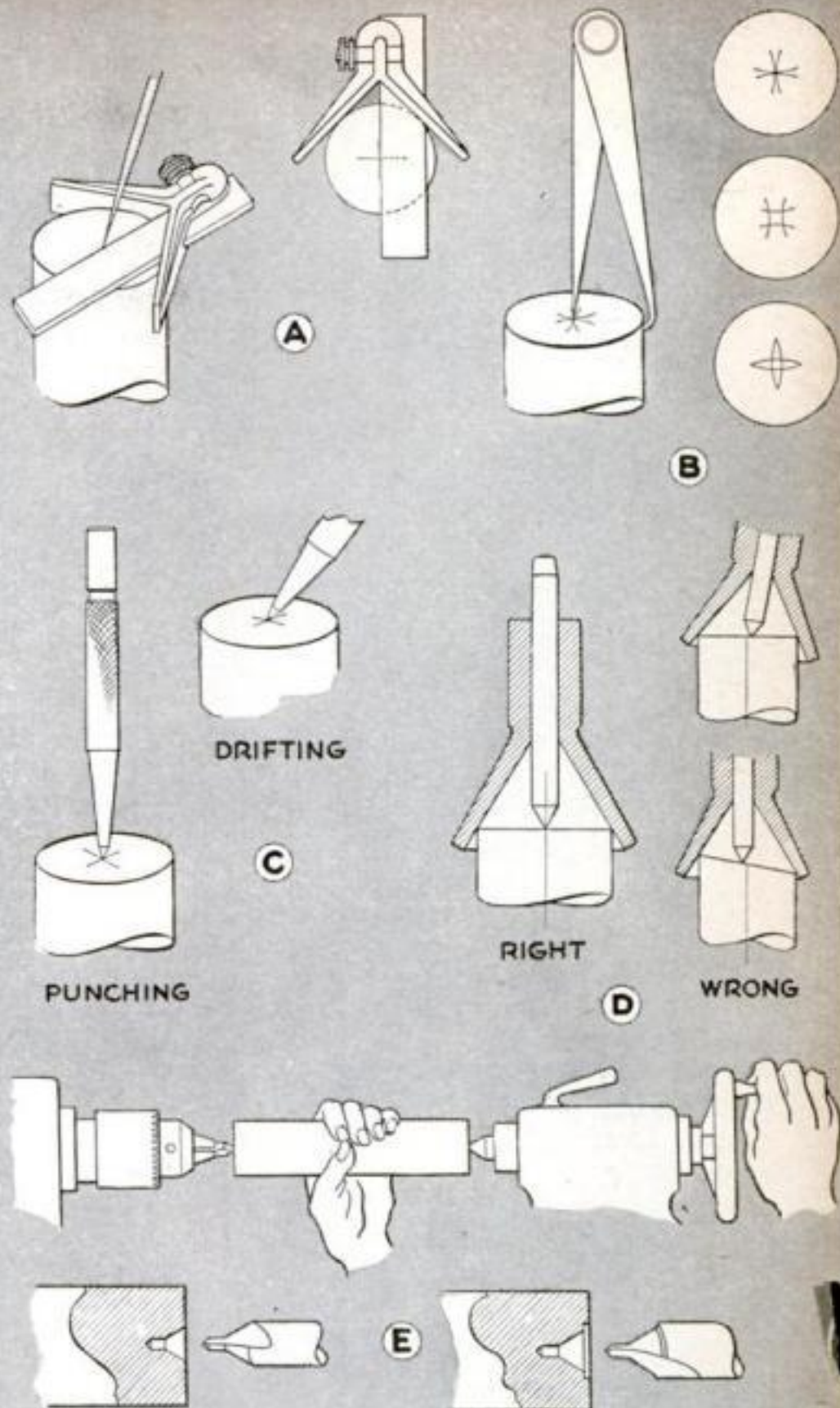
POPULAR SCIENCE MONTHLY SHOP DATA

the Lathe

work. The punch is then held vertically and driven in with the hammer to square the sides of the hole, after which the work should be tested again.

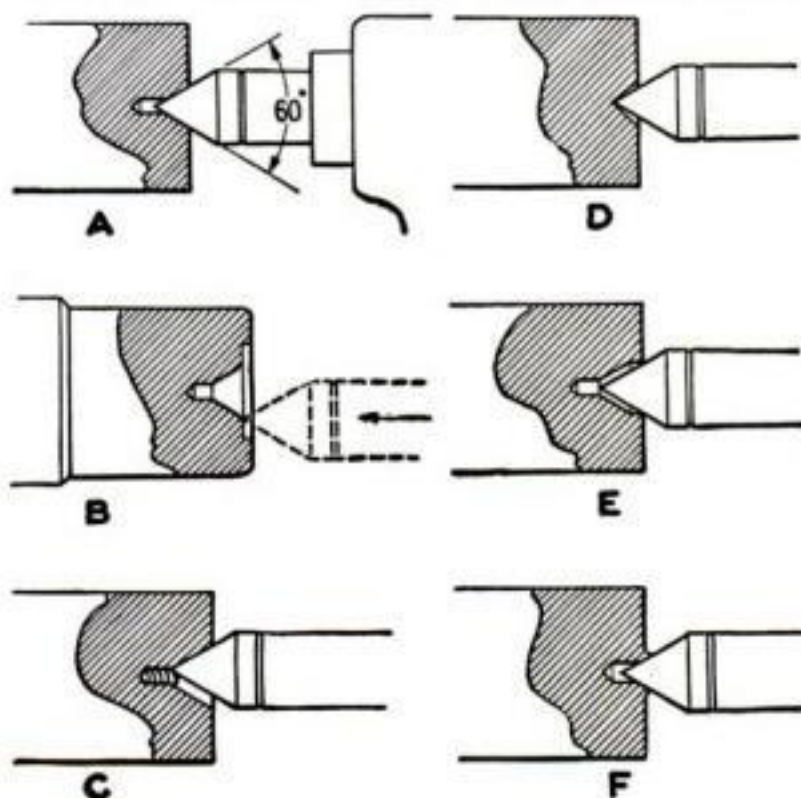
A bell centerpunch is convenient for centering a number of small cylindrical pieces. The cup is placed over the squared end of the work as at *D*, automatically locating the punch at the center. It must be held accurately in line with the work, however, or the punch will not be centered properly. Likewise, it cannot be used when the end of the work is cut at an angle.

Punched center holes may be drilled with a combination drill and countersink chucked in the lathe. The work is placed against the tailstock center and held with the left hand while being fed to the drill with the right, as shown at *E* in the drawings. When the hole has been drilled to the proper depth, the work is reversed and the other end drilled. Time can be saved and the countersinking will be sure to be concentric with the hole if a combined drill and countersink (at left at *E*) is used, while the bell-type centerdrill with a double-angle countersink (*E* right) may be used in centerdrilling mandrels and boring bars to reduce the danger of chatter or eccentric work caused by bruising the edge of the center hole.



GOOD AND BAD CENTER HOLES

[LATHE WORK]



Lathe centers are made to the standard angle of 60 deg., and the countersunk or tapered portion of all center holes must have the same angle for a perfect fit, as shown at *A*.

The type of center hole at *B* is best for mandrels, boring bars, and other tools that are used between centers. The rounded edge keeps the point of the lathe center from striking and burring the edge, and the recess in the end prevents bruising of the hole.

The drawing *C* shows a well-formed center hole rendered useless by failure to remove chips from the hole. Under this condition, accurate work is not possible, and the point of the lathe center will soon wear badly.

At *D* the angle of countersink is too large, and there is no hole to keep the point from receiving all of the bearing pressure. Besides the danger of ruining the lathe center, accurate work is impossible.

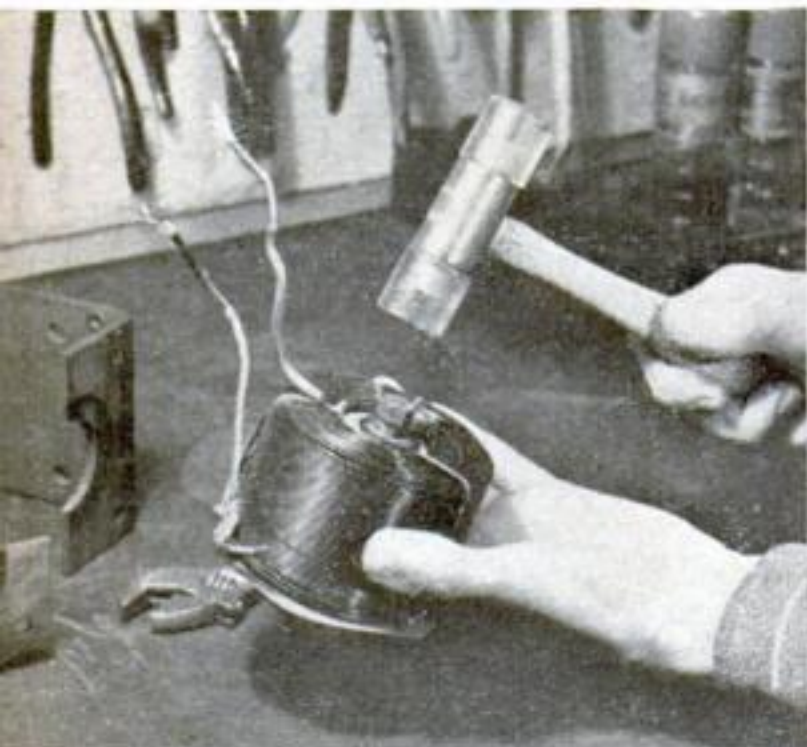
A piece of work in which the countersunk hole has been drilled too deep, allowing only the outer edge to rest on the lathe center, is shown at *E*. This will score the lathe center, and accurate work will also be impossible.

The work at *F* has been drilled but not countersunk—bad practice that will cause the lathe center point to heat and wear rapidly.

POPULAR SCIENCE MONTHLY SHOP DATA

MAGNETIZER and DEMAGNETIZER Is Easily Built from Old Loudspeaker Coil

By WALTER E. BURTON

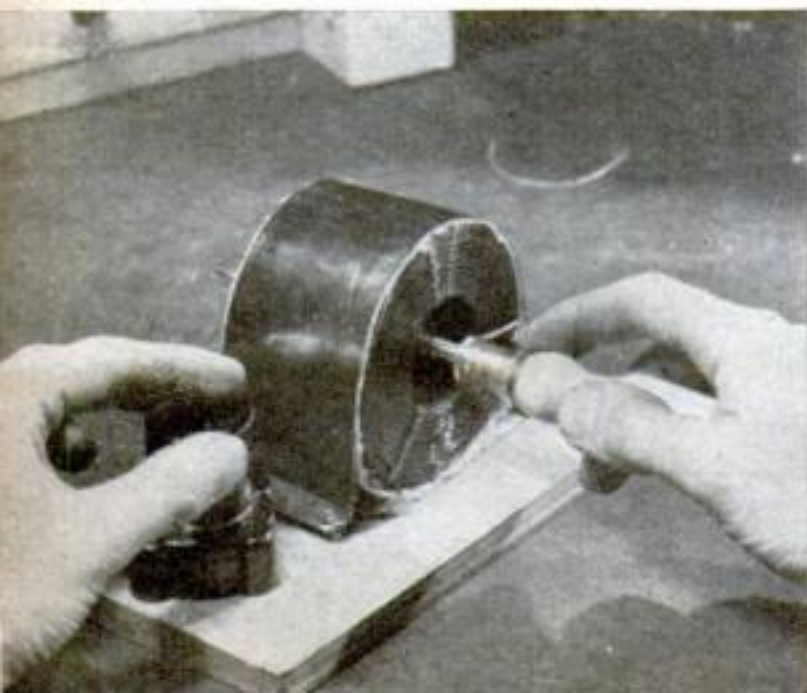


The photograph above shows the first step in making the magnetizer-demagnetizer. The core of a disassembled loudspeaker coil is driven out, leaving a hole $1\frac{1}{2}$ " in diameter



A fiber or sheet-metal strip anchors the coil to a base. Note the plug that short-circuits the socket and energizes the coil when pressed

Below, the unit being used to demagnetize a screwdriver. The switch is held down so that current flows steadily, and the tool withdrawn



A SIMPLE magnetizer and demagnetizer operating from a standard 115-volt A.C. line will make strong magnets of files, screwdrivers, hammer heads, and other tools in which magnetic properties are desirable. As a demagnetizer, it will erase all traces of magnetism from lathe bits and other tools that sometimes become magnetized and pick up steel chips.

The unit consists of a solenoid, or a hollow coil of wire, and a momentary-contact switch to control the current. For the unit shown, the 6-volt field coil from an old electrodynamic radio speaker was used without the iron core, which was driven out. Any coil that draws no more than 5 or 6 amp. on the 115-volt line and is of wire heavy enough to carry this current for 30 seconds will do. In testing such a coil, connect it in series with a 10-amp. fuse or an electric iron or heater to avoid blowing the line fuses.

If no coil is available, you can wind your own solenoid with salvaged magnet wire. A satisfactory one can be made of No. 18 enameled copper wire wound in a coil $2\frac{3}{8}$ " long and 1" deep on a thin-walled fiber tube $1\frac{1}{2}$ " in diameter.

A momentary-contact switch that closes the circuit only when depressed is required, as the coil must be energized only $1/120$ second—for half a cycle of the 60-cycle current—to magnetize a piece of steel, and only a few seconds to demagnetize one.

To make this switch, cut a piece of broomstick to fit easily inside a surface-mounting lamp socket and to protrude about $\frac{1}{2}$ " above the socket. Bend a $\frac{1}{2}$ " strip of copper or brass around one end, forcing the ends of the strip into slots in the wood. This will short-circuit the contacts when inserted in the socket.

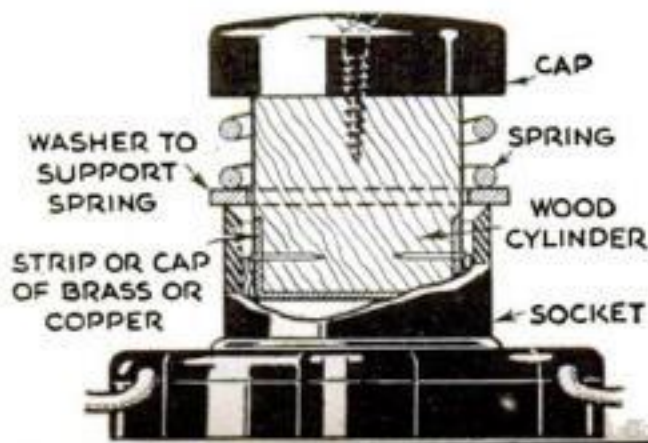
To the projecting end of the plug, fasten a disk of plastic or wood, or a nonmetallic bottle cap. Slip a short compression spring over the plug against the head. Insert the plug so that the spring rests on the insulated top of the socket. Pressure downward makes contact, and the spring forces the plug up when pressure is released, breaking the contact. Connect this switch in series with the solenoid.

Anchor the coil, so that the hole is horizontal, with a strip of fiber or metal bent around it and screwed fast to a baseboard. If the strip is metal, put a layer of asbestos or cardboard between it and the coil.

To magnetize a piece of steel, insert it in the coil and press the button. A single, swift tap is enough. To demagnetize a tool, hold the button down and draw out the piece while the current is still flowing.

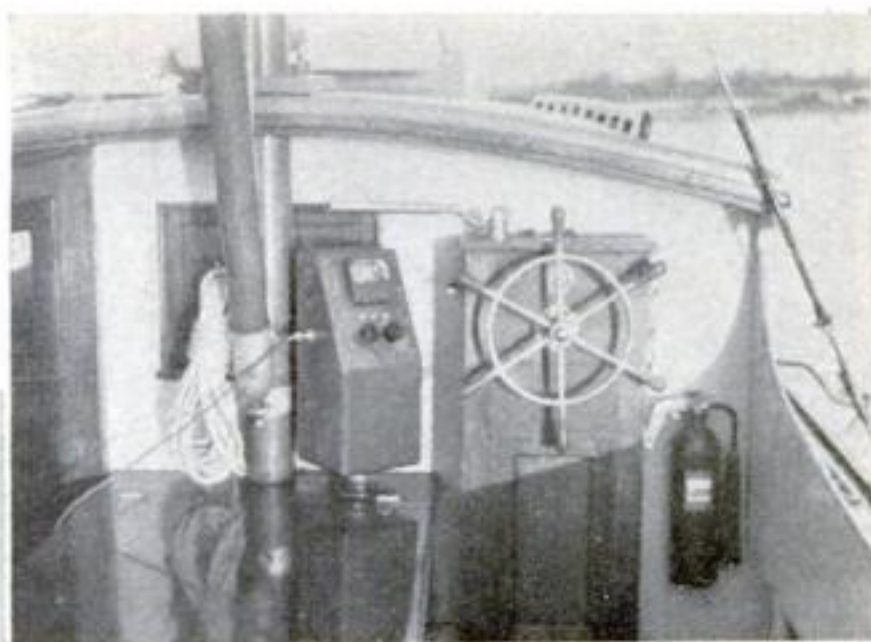
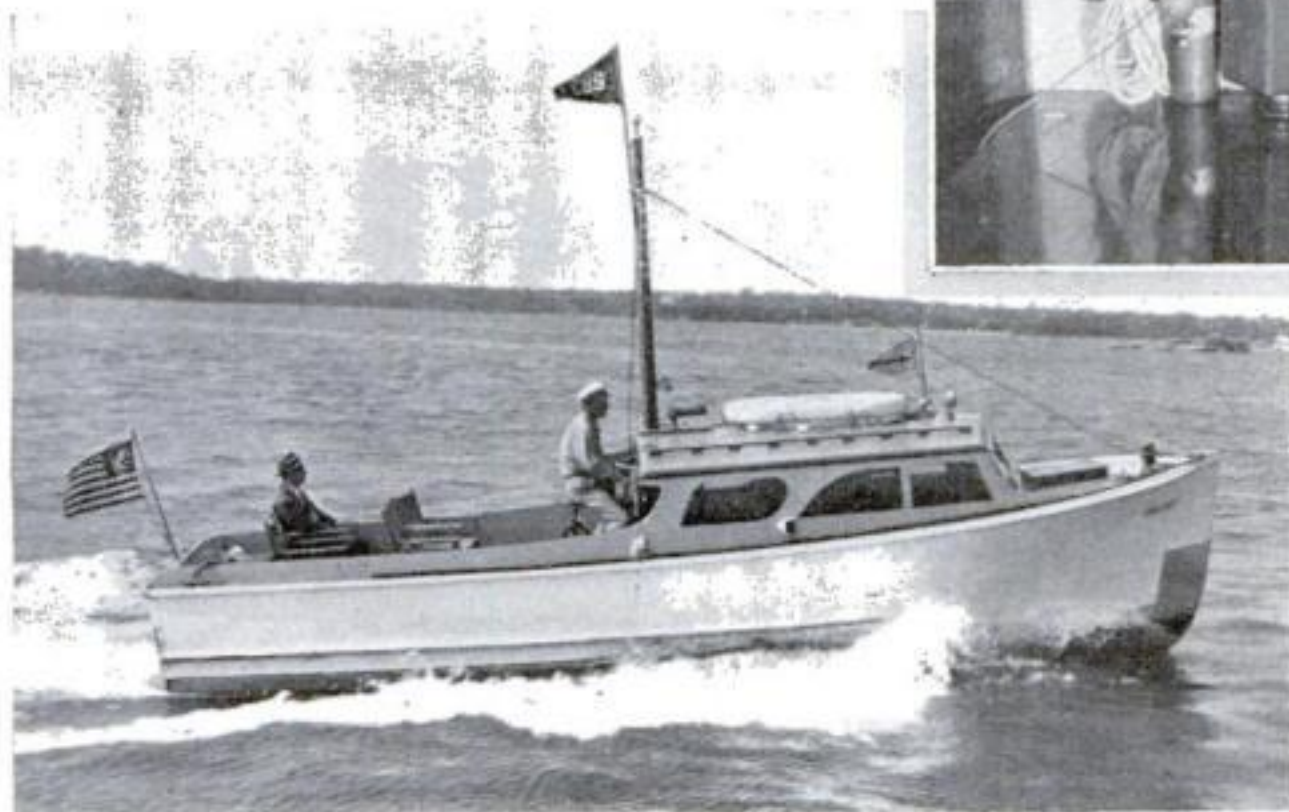
Be sure all connections are soldered or clamped and all terminals, joints, and wires adequately insulated.

Contacts are closed in the improvised switch at right when a wooden plug with a metal tip is depressed. A light spring otherwise keeps the plug out of contact



ELECTRONIC NAVIGATOR

Guides Ferryboats Through Fog



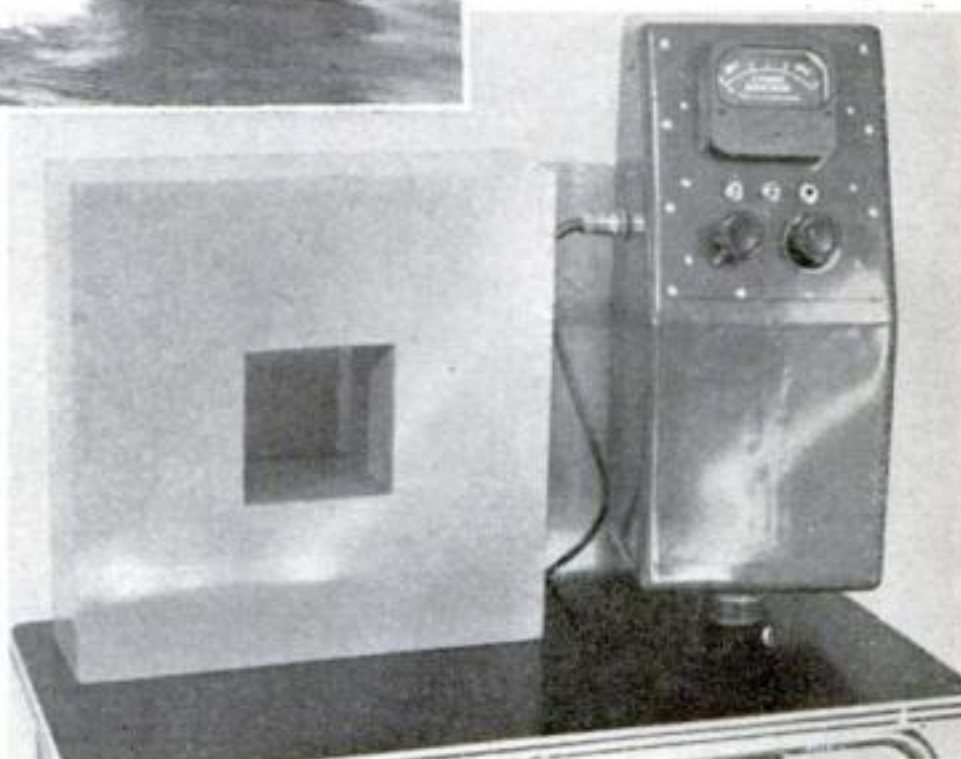
Launches serving WABC's big island transmitter are guided through fog by the electronic device above. Its coil, located in the bow, is shown below on a table with the amplifier

WHEN station WABC, of the Columbia Broadcasting System, erected its 50,000-watt transmitter a few years ago on a tiny island in Long Island Sound a mile off New Rochelle, N. Y., a ferry service was inaugurated for engineers and other members of the staff.

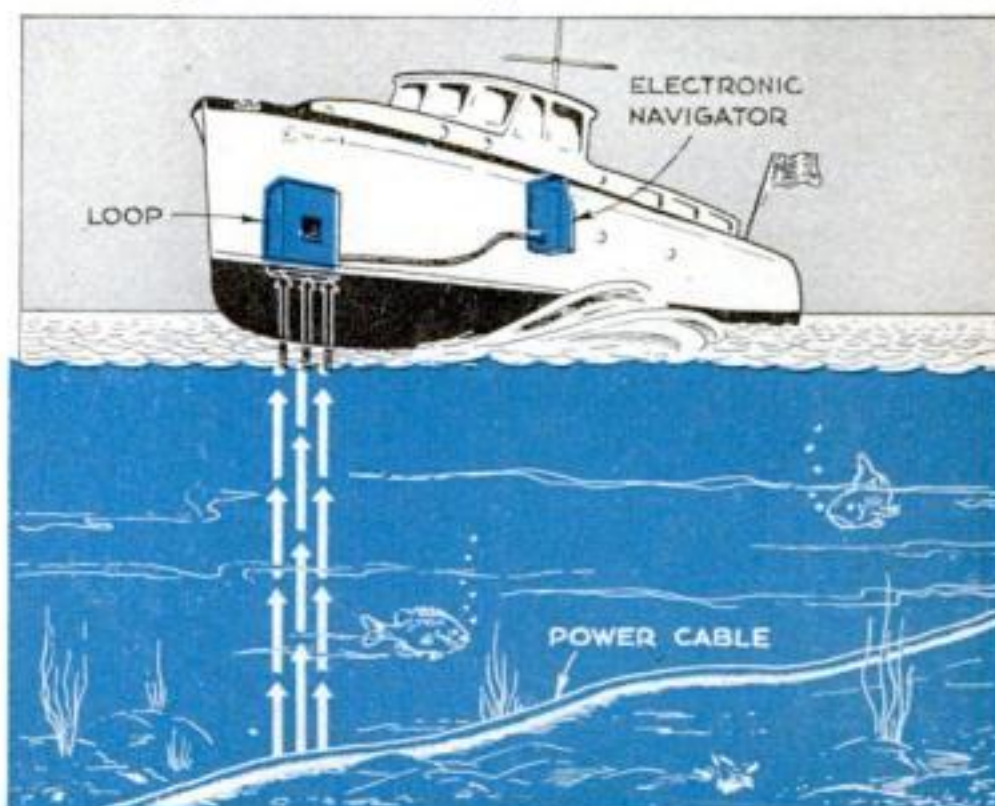
During certain months of the year, however, service was affected when the island and mainland became totally obscured by dense fogs of long duration. In order to insure safe navigation during these periods, CBS engineers devised an electronic navigator to guide the boats by following the power cables under the water.

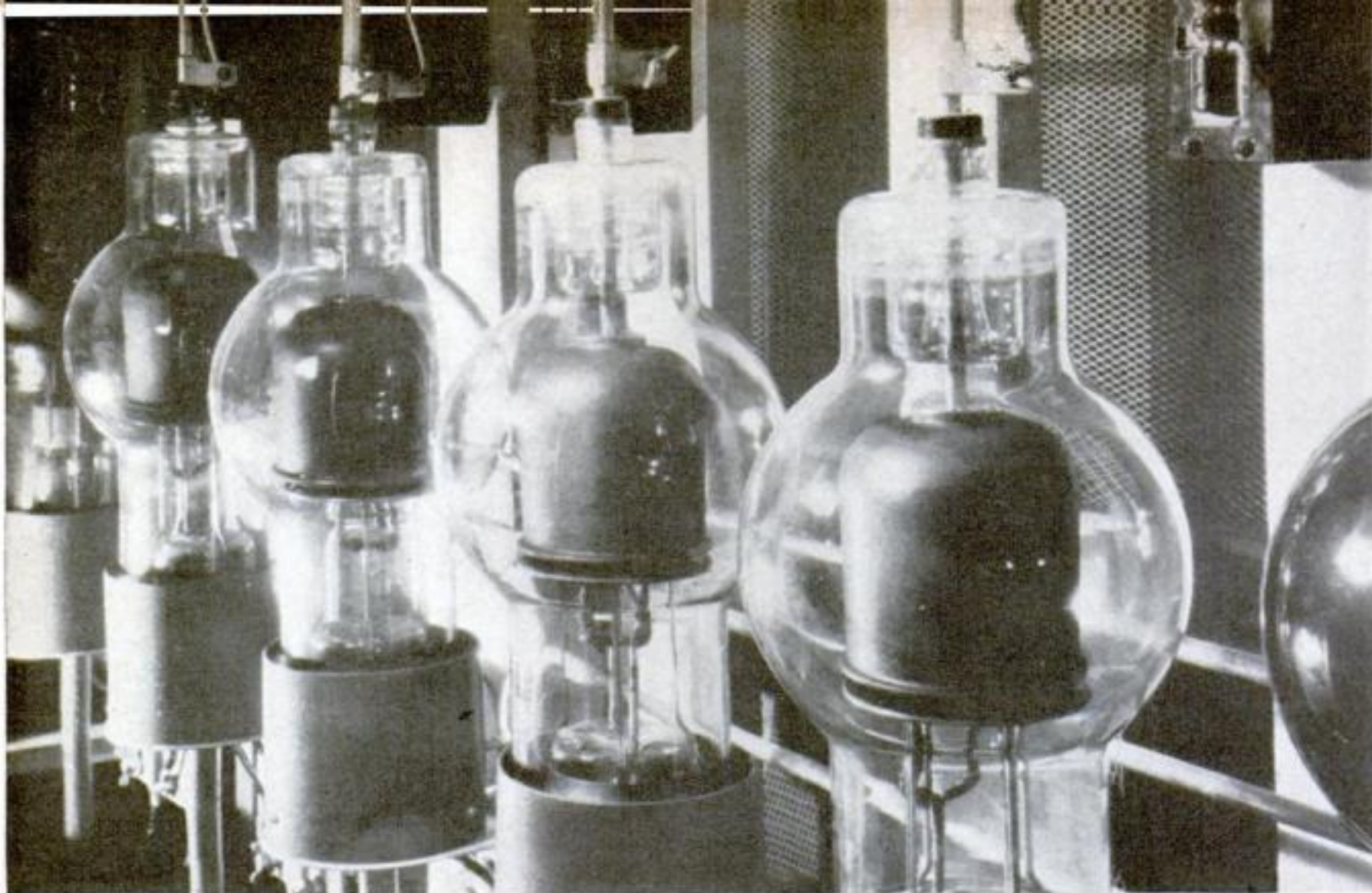
The flux lines of the magnetic field surrounding the cable induce a current in a specially built coil encased in a wooden box in the bow of the boat. A portable amplifier with a voltage gain of 86 decibels steps up the current gain from the loop, and the output is fed to a volume-indicator meter used as a course indicator. The amplifier is adjusted so that, when the boat is directly over the cable, a maximum deflection of the needle is shown on the meter.

The system is really an induction device basically similar to experiments that perhaps many readers of *POPULAR SCIENCE* have tried with headphones, microphones, and large loops.



Current is induced in the electronic-navigator coil by the magnetic flux around power cables under the water





FIRST STEPS IN ELECTRONICS

Giant mercury-vapor rectifier tubes, above, supply 500,000 watts to the transmitter of radio station WLW

Putting Diode Tubes to Work

By JOHN W. CAMPBELL, JR.

Danger! High Voltage!

This familiar warning is often seen near transformer stations and high-tension lines. It might well be hung over your electronic bench. Even 110-volt house current can be dangerous under certain conditions—and the secondary potential of a common radio plate-current transformer is several times this. A healthy respect for such equipment is the experimenter's only safe policy.

DON'T TOUCH WIRES or do any work on a setup without first disconnecting it from the power line. If you only switch it off, you may accidentally close the switch.

NEVER TRUST CONDENSERS. The better the condenser, the less it is to be trusted. Be sure it's discharged before touching it. A good condenser can hold a charge for as long as a week.

BEWARE OF WATER. Moisture makes conductors of insulators, especially when high voltages are present. Stand on a dry floor when working with electronic equipment.

Observing ordinary precautions, thousands of radio amateurs have worked with 5,000 volts and more without mishap. You can use electricity safely—if you realize how dangerous carelessness can make it!

MORE than 100 horsepower of electrical energy—1 amp. at 100,000 volts—flows into the giant industrial X-ray tube that spots defects in heavy steel castings. Possibly in the same plant there is an "electric eye," or phototube, that gauges the color of incandescent metal in a Bessemer converter and signals when the blast must be shut off. This tiny diode may draw a current of five millionths of an ampere at 85 volts. Yet both these electronic tubes may be energized from a standard 110-volt or 220-volt A.C. line.

This is possible because A.C. of any given voltage can readily be converted to a higher or a lower voltage by means of a transformer. Typical of the flexibility of A.C. is your radio power-supply transformer, which from the 110-volt line supplies 5 volts for the rectifier-tube filament, 6.3 volts for amplifier-tube heaters, and perhaps 350 volts for plate current.

However, since electrons in electronic tubes can pass only in one direction, such tubes are essentially direct-current devices. Therefore, once A.C. has been converted to the voltage required, it must in most cases be rectified—changed to direct current. We have seen that the electronic tube itself is fundamentally a rectifier. If A.C. is applied to the cathode, the tube will pass current only on that half of each cycle when the cathode

is negative. Why not, then, use a special tube to turn A.C. into D.C. for use in the rest of the circuit? This is precisely what is done in A.C. radios and a host of other electronic devices.

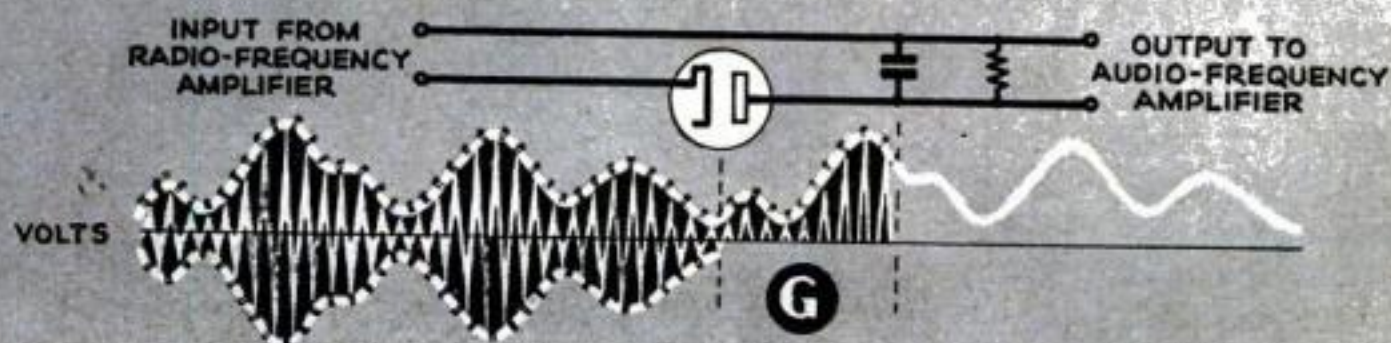
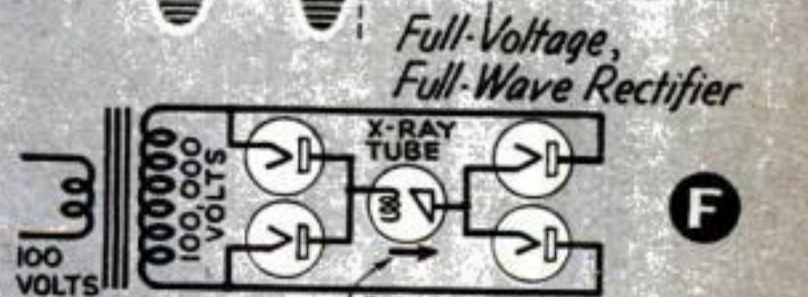
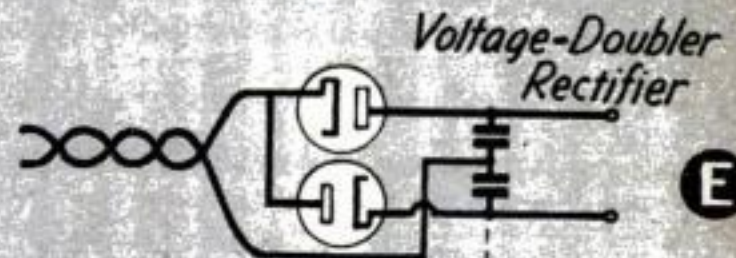
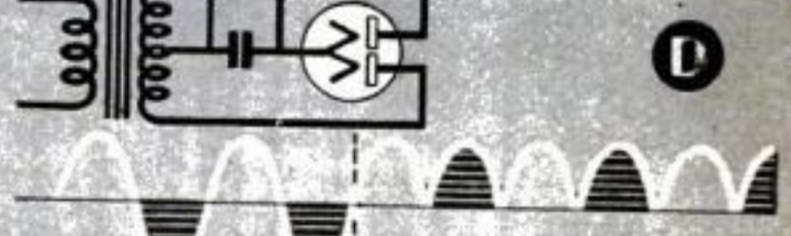
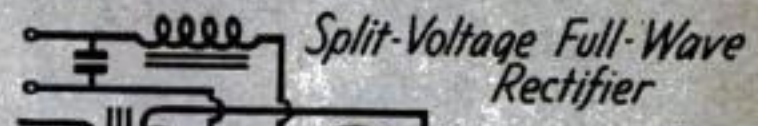
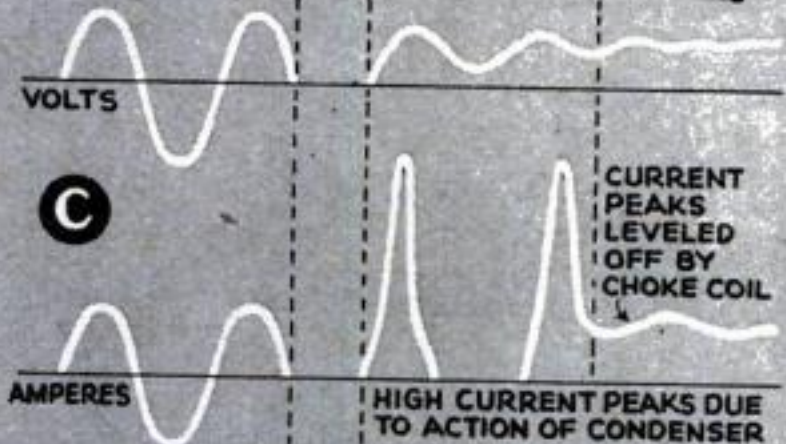
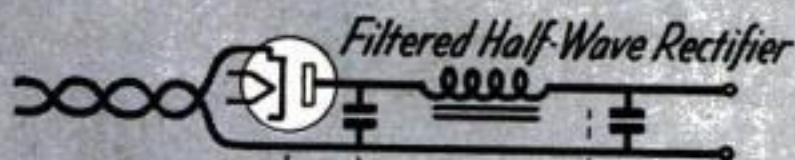
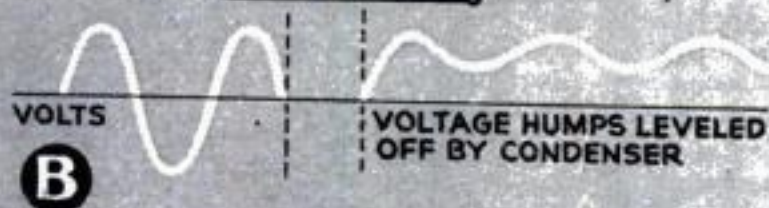
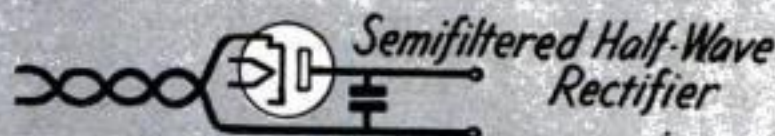
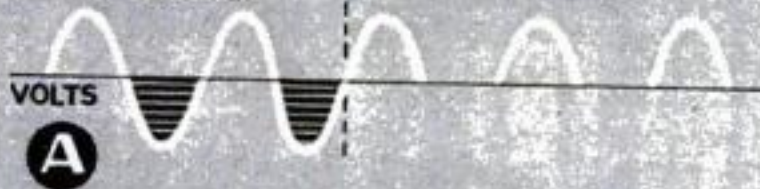
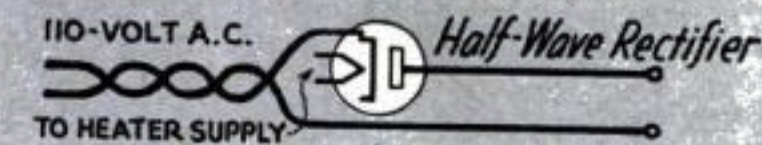
The simplest of all rectifier circuits is shown in Fig. 1 on page HW 492 and at A in the drawings. This "half-wave" rectifier converts A.C. to D.C. by cutting off one half of the A.C. cycle and passing only the other half, during which current flows in only one direction. In the setup shown in the photograph, a 117Z6-GT tube was used, only one of its two rectifying units being connected.

As the heater of this tube can be connected directly across the line, no filament transformer is needed. If another tube is used, the heater must be connected to trans-

former taps giving the correct voltage. All heater connections are omitted in the diagrams for the sake of clarity.

The output of this half-wave rectifier is 60 pulses of direct current per second, as evidenced by the rapid flickering of an argon bulb connected to it. Such D.C. is perfectly satisfactory in many applications, but for others its pulsations must be smoothed out.

The simplest answer is an 8 to 40-mfd. condenser across the output terminals, as in Fig. 2 and in diagram B. The condenser acts as a tiny reservoir, storing current on each impulse, discharging between pulses, and so supplying current when the tube does not. However, the voltage on its plates must drop a little between charges. Although the output current will no longer be discontinuous (unless the condenser is very small or



the load very heavy) there will be ripples in the voltage, and consequently in the current. The bigger the condenser and the smaller the load, the less ripple will result.

With the condenser, the argon lamp no longer flickers appreciably. But let us connect a loudspeaker in parallel with the lamp, putting a 2,000-ohm resistor in series with the speaker to avoid overloading the circuit. Being much more sensitive to current irregularities than the lamp, the speaker hums strongly.

Good radio sets have a ripple of about .25 percent— $\frac{1}{4}$ volt in a 300-volt output. The resulting hum is so slight as to be imperceptible. This filtering could be achieved with the circuit of Fig. 2 if the condenser were large enough. But there is a limit to its size in theory as well as in practice.

A 1,000-mfd. condenser, if available, could not be attached to any ordinary rectifier tube without disastrous results. Any discharged condenser offers practically no resistance to the first surge of current; only when the potential on its plates builds up is there any limit to the rate at which current can flow into it. A 1,000-mfd. condenser would act as a dead short-circuit across the tube for a fraction of a second, with the inevitable result that the tube would be ruined.

But we can solve the problem, as shown in Fig. 3 and at *C* in the drawings, by using two condensers with a choke coil (an inductance) between them. A condenser will draw 1,000 amperes for a millionth of a second and then stop; an inductance has very different ideas. When current increases, the inductance converts the extra energy into magnetic lines of force and chokes off the surge. When current decreases, the lines collapse and augment the current flow. Thus the choke coil holds the current draw of the condensers to a more reasonable value. Furthermore, its storage and discharge of energy also tends to smooth out current ripples.

So far, we have used only one half of the alternating current, getting 60 pulses per second. If we can invert the other half of the cycle somehow, we will get 120 pulses a second and much smoother power. Figure 4 shows how this full-wave rectification can be obtained. Two diodes are needed, but most rectifier tubes of this type have two diode elements—usually two plates with a common cathode, as in drawing *D*. The 80, 82, and 83 are such types. The 117Z6-GT has two plates and also two cathodes,

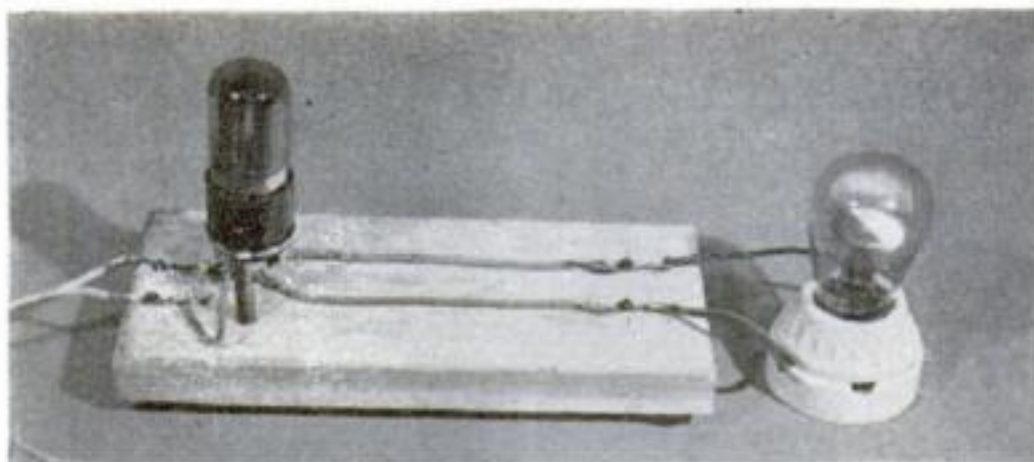


Fig. 1. Only one plate of the argon bulb glows, but with a perceptible flicker, showing that the output, although D.C., consists of separate current pulses

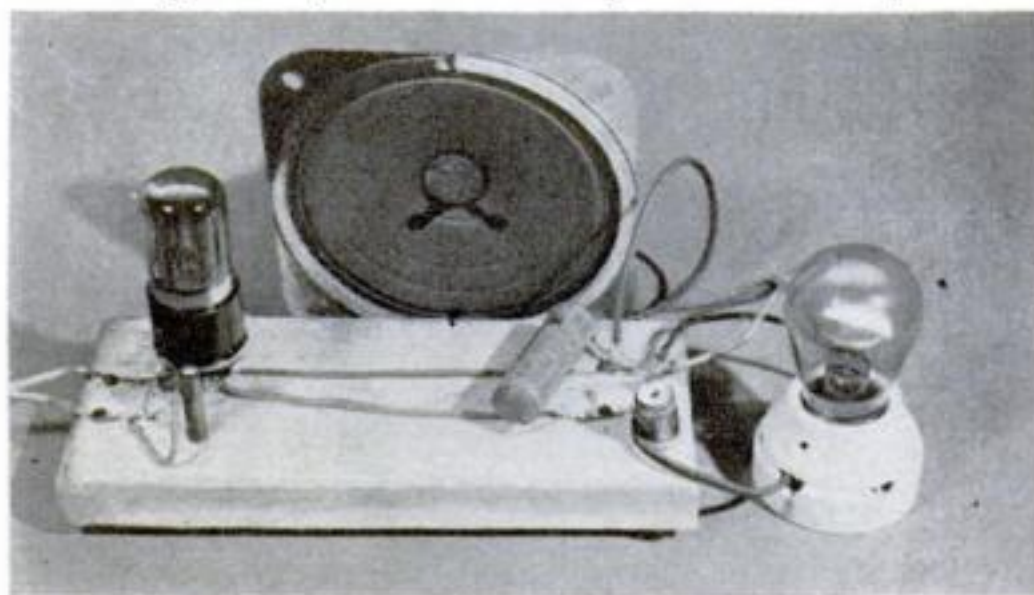
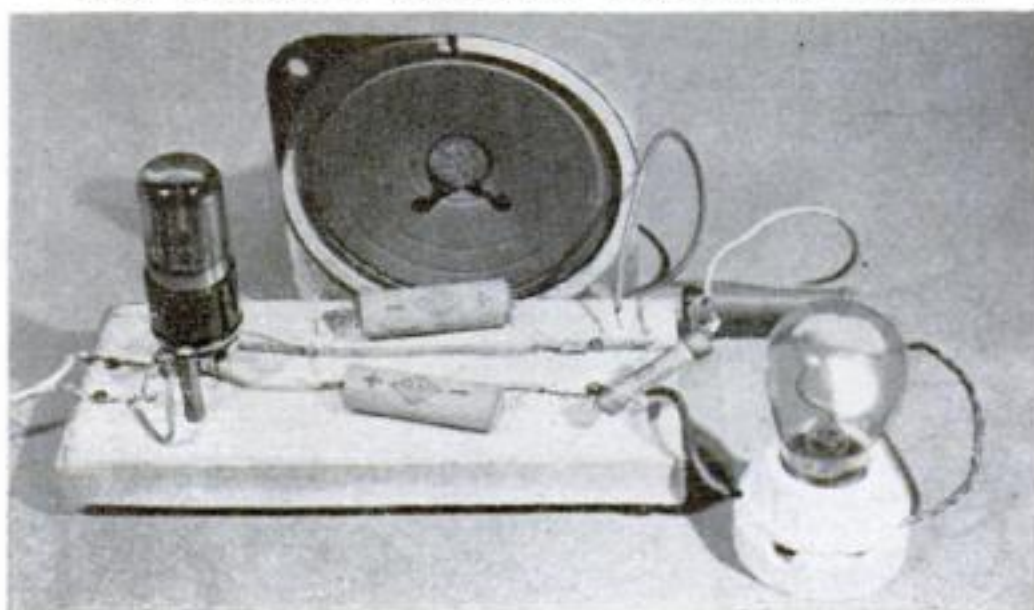


Fig. 2. A condenser across the output eliminates the flicker. If a speaker is connected, however, a loud hum tells that current fluctuation is still present



Fig. 3. The speaker is silent when two condensers and a choke are used, but the bulb shows current flowing

Fig. 4. A double-diode tube connected to give 250 volts. Resistances protect the bulb and the speaker



thus permitting it to be used as a full-wave rectifier and also as a voltage-doubler, a different type of full-wave rectifier shown at *E*.

This voltage-doubler, used in compact radio sets, eliminates the need for a transformer yet produces about 250 volts of plate supply at 120 power impulses a second. The two halves of the A.C. wave are fed to separate condensers, but instead of being in parallel, the two condensers are in series. Since each one is charged to the peak of the A.C. voltage, the resultant is twice this peak voltage. But "110 volts" of A.C. means an *average* value of 110 volts. Between the wave peaks the voltage is zero, and much of the time it is below 50 volts, but the peak value of ordinary household current is 156 volts.

With no load drawn from them, the condensers in diagram *E* would charge up to the highest voltage given by the rectifiers—156 volts each, minus a little because of voltage drop in the tubes. The result is that the output of the two condensers is 250 to 300 volts. A 10,000-ohm resistance should be used in series with the argon bulb, and one

of 25,000 ohms in series with the speaker.

At *F* in the drawings is a four-diode grid system for full-wave rectification. Remembering that electrons can pass only from cathode to plate, you will see that the current will always flow in the same direction through the load, which is shown as an X-ray tube.

Diagram *G* shows another interesting half-wave rectifier-filter circuit. This is the same circuit as at *B*, with a resistance across the output leads. But whereas a condenser of 20 mfd. might be used in *B* to smooth the current, in *G* one of a fraction of a microfarad would be used—a condenser so small that the charge on it would be drained out through the resistance in .0001 second. It wouldn't filter out 60-cycle or even 10,000-cycle hum at all, but it is big enough to smooth out perfectly the hum of a 600,000-cycle radio carrier wave. Its output will be free of radio-frequency oscillations, yet will pass on all the audible, lower-frequency signals—voice or music—which were impressed upon the carrier wave in the form of amplitude modulation at the transmitter.

Heavy-Duty Plate-Current Supply for Electronic Experiments

YOU will need a source of rectified plate current for further experiments with electronic tubes. If the old radio you dismantled had a power transformer, this can be used. Shown below is a 350-volt, full-wave rectifier unit using a type 83 mercury-vapor tube, the two plates of which are connected as in diagram *D* on page HW 491.

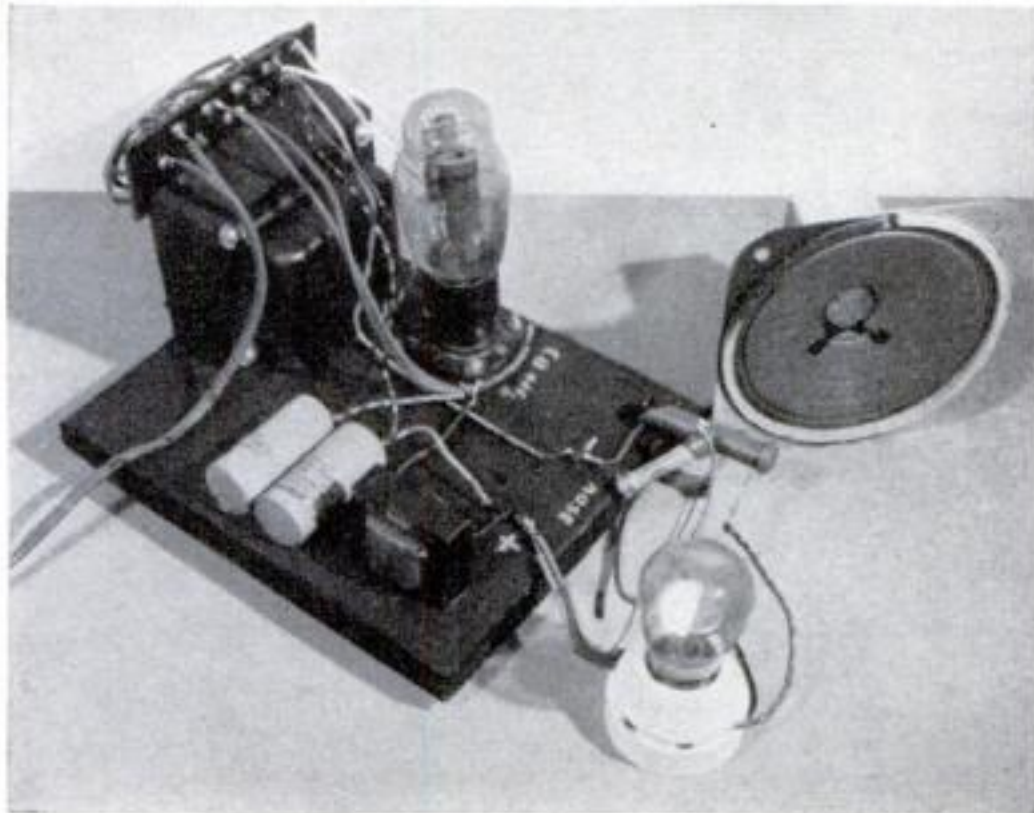
Note that the 350-volt secondary winding of the transformer must have a center tap for this hookup, which requires three leads.

This power supply will prove useful in later experiments. If you have no transformer, assemble the circuit shown in Fig. 3

In the photograph, these appear at the extreme right of the transformer. To the left of these are the 5-volt leads which go to the twin filament-cathode, and at the extreme left are the two black primary leads. The tube will carry 225 milliamperes continuously and overloads of 1,000 milliamperes momentarily. Two 16-mfd., 450-volt condensers are used with an ordinary filter choke. The filtered 350-volt output causes no hum on the speaker, but the argon lamp shows that rectified current is flowing. Resistors of 10,000 ohms and 25,000 ohms are used in series with the bulb and speaker respectively.

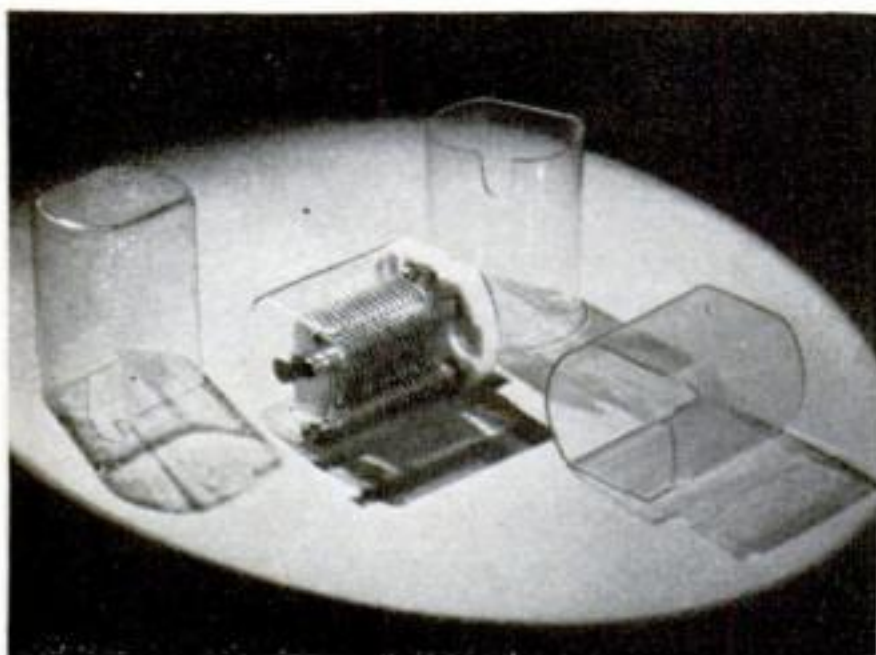
Never connect this or any other rectifier to the line without a load such as an argon bulb or a 25,000-ohm resistor across the output, as damage to the condensers may otherwise result.

If the tubes you have on hand are not the type mentioned, consult a radio handbook or a manual such as is published by tube manufacturers for others that may be used—the 5Y3-G, 5Y4-G, 5U4-G, 80, and 82 are a few of them. Such receiving-tube manuals include diagrams showing socket connections for various tubes. Consequently they are useful additions to the reference library which every experimenter should have.



radio ideas

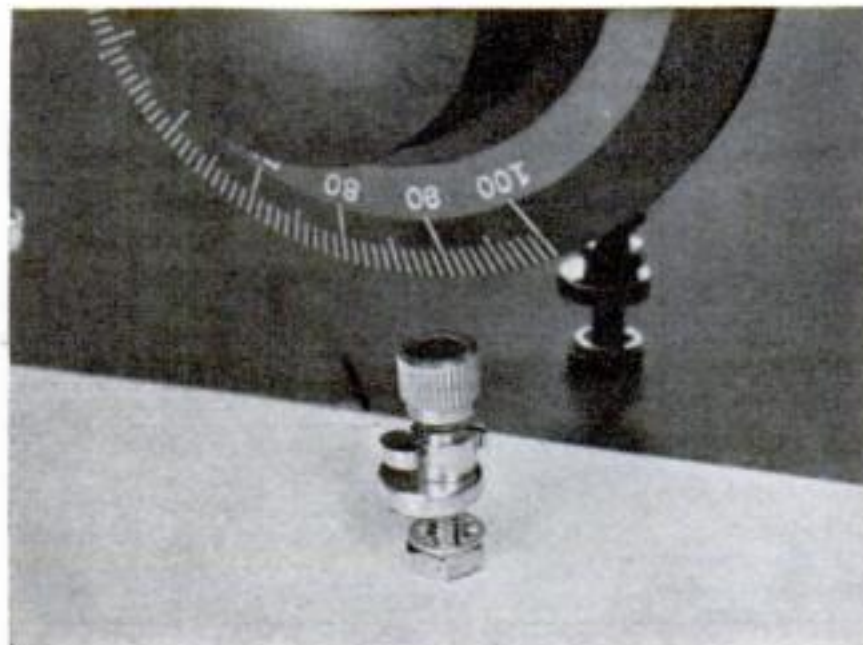
CERAMIC BATTERY CASES are replacing those formerly made of rubber for industrial, public-utility, emergency-transmitter, and telephone service. Four clays are blended to produce this vitrified ceramic, which is acidproof, is easy to keep clean, and can be heated to 212 deg. F. and plunged into ice water without contraction. Cases made of the material may be used safely next to other electrical equipment. Since their predominant color is white, they also help to brighten a dark battery room and make a contribution to easier servicing.



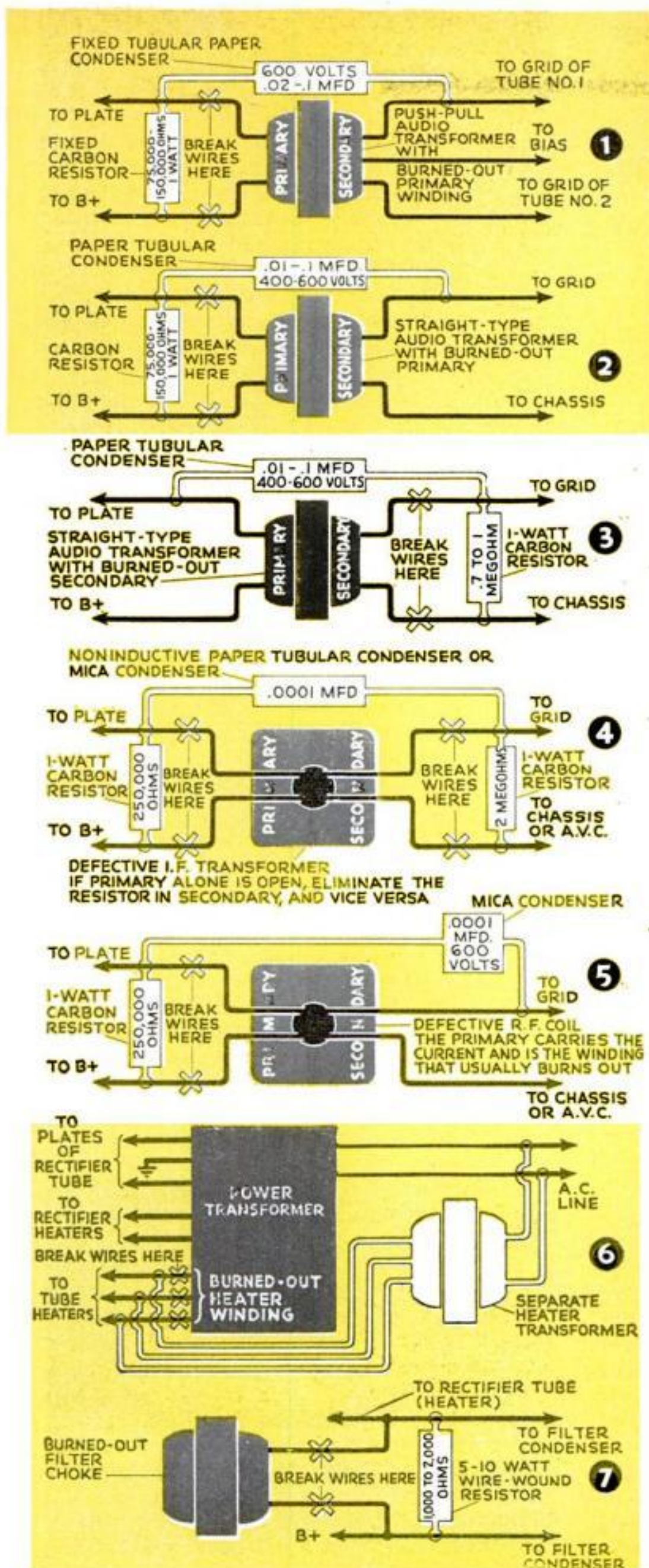
TRANSPARENT PLASTIC COVERS are being supplied to the U. S. Army Signal Corps to prevent dust particles from collecting between the closely spaced plates of small variable condensers required in radio field equipment. The covers are rigid and look something like the transparent containers employed by many manufacturers before the war in the packaging of their products. They are made of a sturdy cellulose acetate material, each being fabricated from a single sheet. When fitted over a condenser, as shown at left, a cover becomes virtually an integral part, often preventing a breakdown of equipment in dusty, sandy areas.



ADJUSTABLE PANEL LIGHTING where variable intensities are required under constantly changing conditions, such as are met in military and aircraft usage, is possible with the new radio panel lamp shown above. Rotation of the shutter permits a gradation of light from full brightness to complete darkness. The lamp is available with a red, green, amber, blue, or opal lens, and also with a polarized lens.



Servicing Your Radio



BURNED-OUT or damaged parts of a radio receiver can often be put back into service without making an actual repair or replacement should either prove temporarily impracticable. This is especially true of such parts as chokes, power transformers, audio transformers, and coils.

You can often use the damaged part itself as a repair if a section of it is still good; if it is not, a simple change in the circuit sometimes will enable you to do without the part. In the latter instance the over-all sensitivity or power might be slightly impaired, but this will not be enough to keep the receiver from being used.

In audio transformers—both push-pull and straight types—it is usually the primary winding that becomes defective. Simply disconnect this winding and replace it with a condenser-and-resistor network, as shown in Figs. 1 and 2. The value of the resistor will depend on the plate impedance of the tube. If the tube is a low-impedance triode, a 50,000 to 75,000-ohm, 1-watt resistor is generally employed; if it is a high-impedance triode, a 100,000 to 150,000-ohm, 1-watt resistor is best. Low notes are improved by using a high-capacity coupling condenser, but it is best to experiment in order to get the best tone value.

A damaged secondary of an audio transformer is similarly replaced (Fig. 3), but the value of the resistor must be much higher—750,000 ohms to 1 megohm.

It is possible to eliminate a damaged stage of a receiver having two or more stages of I.F. or R.F. amplification by changing the circuit so that the stage is resistance or impedance coupled, as in Figs. 4 and 5. Volume will, of course, be reduced, but not enough to prevent satisfactory reception of local stations.

Should the heater winding in a power transformer burn out, a separate 2.5-volt or 6.3-volt heater transformer can be inserted in place of the defective section, as in Fig. 6, and the rest of the transformer used as before. A burned-out filter choke can always be replaced by the simple resistor circuit shown in Fig. 7.

Can I Make



Figure it out for yourself by the square-foot method

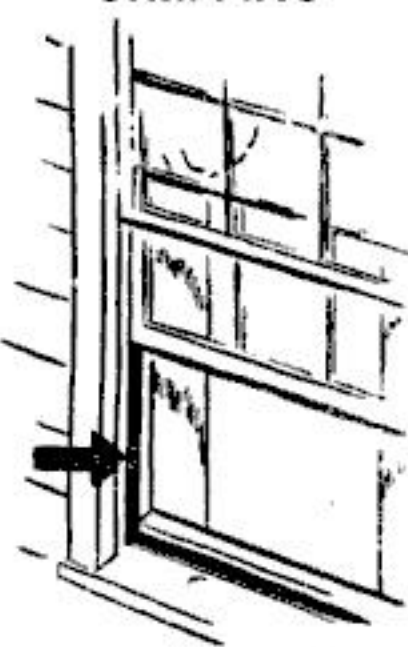
By J. HAROLD HAWKINS

Author of *Your House*

IF THE average heating period for your home is seven months a year, with proper insulation you may save up to four months on your fuel bill each winter. This is important information—doubly important now because of the shortage of both fuel oil and coal. But this estimate of your saving must presuppose that you are going to do a thorough job of insulation—not leave cracks at doors, windows, and baseboards for the entrance of cold drafts.

The term insulation, as applied to homes during these times of widespread restrictions in many fields of manufacture, includes loose, batt, and blanket types for wall and

WEATHER-STRIPPING



ceiling installations; double or storm windows; weatherstripping for windows and doors; and calking compounds for stopping infiltration of cold air around window and door frames. All these are available to home owners in any quantity regardless of the \$200 limit set by the Government on home upkeep and repair. This includes metal weatherstrips made of

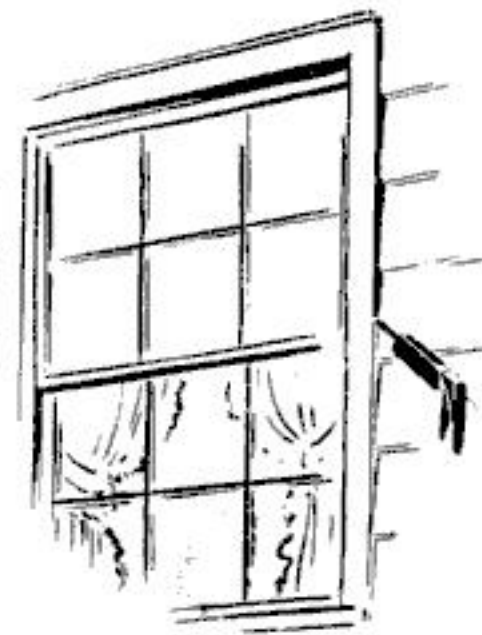
zinc as well as wood and steel storm windows.

Private tests, Government tests, tests and experiences of large manufacturing concerns, and university laboratory tests where both outside and inside temperatures and the relative humidity in the air were artificially controlled, have proved beyond doubt the intrinsic value of home insulation in its several forms.

This is made rather emphatic in a recent information circular from the U. S. Bureau of Mines. "There is, of course," this circular says, "a definite relation between heat conservation and fuel saving. The quantity of fuel that may be saved by insulation has

been determined by many investigators, and results vary considerably, but in every instance the figures obtained are remarkably large."

And more important still to home owners, it goes on to say, quoting from a Bureau of Standards tabulation: "(it) estimates fuel savings up to 40 percent due to the application of simple heat-loss preventives to walls and roof of an unprotected house, and with suitable weather-stripping and storm sash ap-



CALKING

plied to doors and windows, the total savings were boosted to 60 percent."

Because they are lived in, all houses are subject to moisture which, as water vapor, tends to equalize itself with the vapor content of the outdoor air. In winter, outdoor air has a low relative humidity, and water vapor inside the house tends to pass through the walls to be equalized with the outdoor air. This warm vapor passing through a wall will condense as it arrives at a cold surface that is below its dew point.

A small amount of condensation does little or no harm. However, when the relative humidity inside a house is high and the temperature outside is cold, the excessive condensation within an outside wall, with a moisture-resistive barrier on the outside

House Insulation Pay?

surface such as waterproof building paper over the sheathing, may be destructive whether the wall is insulated or not. If loose-fill insulation is introduced from outside, it is a good precaution not to replace the waterproof paper taken off during the process.

Laboratory tests on such a wall have been made to determine safety limits regarding condensation. These tests were made with the indoor temperature at 70 deg., indoor relative humidities varying from 15 to 70 percent, and outside temperature from 20 deg. below zero to 20 deg. above zero. The results of these tests indicate that, on an average, an inside relative humidity of 15 percent is safe at 20 deg. below zero; 18 at 15 deg. below; 22 at 10 below; 27 at 5 below; 33 at zero; 40 at 5 above; 49 at 10 above; 58 at 15 above; and 72 at 20 deg. above zero outdoors.

These limitations of the ratios between inside humidity and outside temperatures are important in any house. They are still more important when an existing wall having a waterproof paper on the outside under the siding is filled with insulation without benefit of a vapor barrier.

Insulation applied between the studding of a wall while it is being built makes it possible to have a vapor barrier between the insulation and the inside surface of the wall. Batts and blankets are available with vapor-proof coverings for this purpose. In an existing house, they can be applied over ceilings with the vaporproof side facing the inside of the house, but this is not feasible in the walls. A coat of size and two coats

of oil paint on the surface of the plaster inside a house will help to turn back vapor tending to pass through the wall.

Other usable information regarding insulation in general has been made available by the American Society of Heating and Ventilating Engineers and by G. D. Lortz, of the Technical Committee of the National Mineral Wool Association. Certain key figures or ratings have been assigned to 77 different localities in the United States according to the average winter temperatures prevailing there. A relative figure for practically any locality, including your own home community, can be selected by referring to the list of these 77 cities—given on the following page—and finding one of them that is nearest to your locality, both geographically and from the standpoint of temperatures.

Inasmuch as the major aids in conserving heat are attic-floor insulation, side-wall insulation, and storm sash, these three items are taken into consideration when figuring the fuel oil saving per season to be achieved by the use of any or all of them in an average house of any given size in any locality.

This method of figuring fuel saving is conservative, as the figures given in the table for ceiling, wall, and window treatments have been reduced by 20 percent to allow for variations in weather and for differences in home construction. These computations are also based on an average of 70-percent efficiency of the heating plant, which is good performance.

The method of figuring the fuel saving possible for your own home is a simple matter of arithmetic. For example, suppose your home is in Grand Rapids, Mich. The nearest city on the chart is Detroit, which has a key figure of 6.460. Now figure the square feet of attic-floor area in your house, the wall area, and the window area. Suppose the attic floor totals 800 sq. ft., the walls 1,200 sq. ft., and the windows 240 sq. ft.

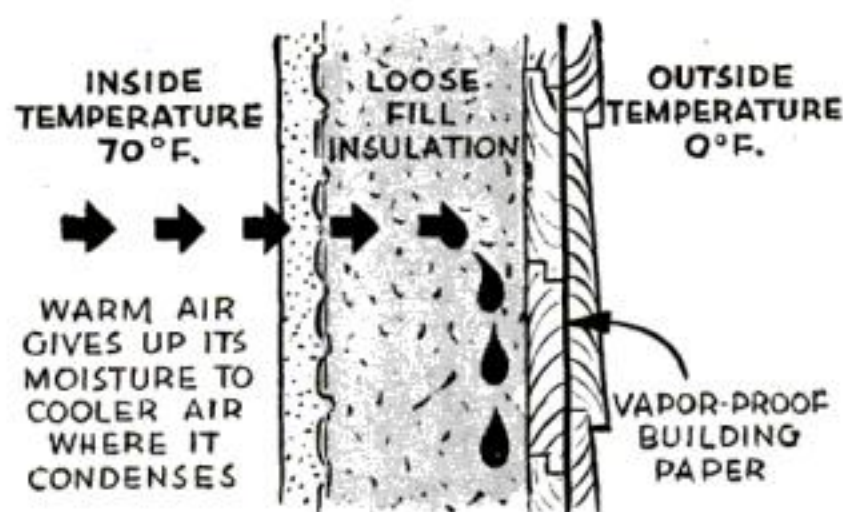
On the insulation chart given below the list of cities, the figure for 3" insulation between ceiling joists is .053. Multiply the key figure representing Grand Rapids (6.460) by the area of the ceiling (800), and then multiply this product by the insulation figure (.053). Thus: $6.460 \times 800 \times .053 = 273$. This



STORM SASH

INSULATION





Condensation in the fill could have been avoided here by putting the paper next to the inside wall

represents the number of gallons of fuel oil saved by insulating the ceiling 3" thick.

For the saving to be realized with insulation the full thickness of a wall framed with 2" by 4" studs, multiply 6.460 by 1,200 by .035. The result is 271 gallons saved.

The same method holds for saving by the use of storm sash: $6.460 \times 240 \times .133 = 206$. The total saving in fuel oil if all three of these things are done to this size house in Grand Rapids will be 750 gallons.

If you burn coal, divide 750 by 170 to get 4.4 tons—the total saving in fuel reduced to terms of coal. This computation is based on the fact that an average ton of coal equals 170 gallons of fuel oil burned in domestic heating plants of average efficiency.

The saving in the amount of fuel is easily translated to savings in cost to you by multiplying the gallons or tons by the price you pay in your locality for either fuel.

All window and door openings in a house are likely places for the infiltration of cold air during winter. Loose-fitting sash and window and door frames that are not wind-tight will do much to reduce the possible saving in fuel by the use of insulation and storm windows. To prevent this, the use of weatherstripping around sash and doors is advisable, and the calking of all frames on the outside of the house will add to the fuel saving. Weatherstripping that you can install yourself is available, or you can hire experts to do the job. Calking is no more difficult than puttying, and a calking gun will speed up the job. Calking compounds are available in light and dark colors.

FIGURE YOUR FUEL SAVING FROM THE INFORMATION BELOW

BELOW is a list of representative cities throughout the country along with a key number, or coefficient, by which the area of your insulated space (in square feet) can be multiplied in calculating your fuel saving as explained in the text above. At the end of the table is another set of coefficients for the type of insulation used.

State	City	Coefficient	State	City	Coefficient	State	City	Coefficient
Ala.	Birmingham	2.410	Me.	Eastport	8.476	Ore.	Baker	7.216
	Mobile	1.473		Portland	7.210		Portland	4.442
Ariz.	Phoenix	1.405	Md.	Baltimore	4.525	Pa.	Philadelphia	4.784
Ark.	Fort Smith	3.112	Mass.	Boston	6.003		Pittsburgh	5.183
	Little Rock	2.863	Mich.	Detroit	6.460	S. C.	Charleston	1.721
Calif.	Los Angeles	1.472		Marquette	8.721		Columbia	2.362
	San Francisco	3.244	Minn.	Duluth	9.797	S. D.	Huron	8.174
Colo.	Denver	5.894		Minneapolis	7.883		Rapid City	7.219
Conn.	New Haven	5.918	Miss.	Vicksburg	1.851	Tenn.	Memphis	2.957
D. C.	Washington	4.631	Mo.	Kansas City	5.002		Nashville	3.500
Fla.	Jacksonville	.928		St. Louis	4.539	Tex.	Fort Worth	2.178
Ga.	Atlanta	2.865	Mont.	Havre	8.635		Houston	1.143
	Savannah	1.524		Lincoln	6.053	Utah	Modena	6.637
Idaho	Boise	5.614	Neb.	Omaha	6.154		Salt Lake City	5.601
Ill.	Chicago	6.027	Nevada	Winnemucca	6.330	Vt.	Burlington	7.508
	Springfield	5.405	N. H.	Concord	7.287	Va.	Norfolk	3.342
Ind.	Evansville	4.228	N. J.	Atlantic City	5.173		Richmond	3.819
	Indianapolis	5.321	N. M.	Santa Fe	6.087	Wash.	Seattle	5.107
Iowa	Des Moines	6.409	N. Y.	Buffalo	6.818		Spokane	6.312
	Sioux City	7.052		New York	5.290	W. Va.	Elkins	5.659
Kan.	Dodge City	5.056	N. C.	Raleigh	3.179		Parkersburg	4.807
	Topeka	5.103		Wilmington	2.304	Wis.	Green Bay	7.896
Ky.	Lexington	4.600	N. D.	Bismarck	9.127		Milwaukee	7.152
	Louisville	4.185	Ohio	Cincinnati	5.127	Wyo.	Cheyenne	7.503
La.	New Orleans	1.017		Cleveland	6.150		Lander	8.277
	Shreveport	1.964	Okla.	Oklahoma City	3.625			

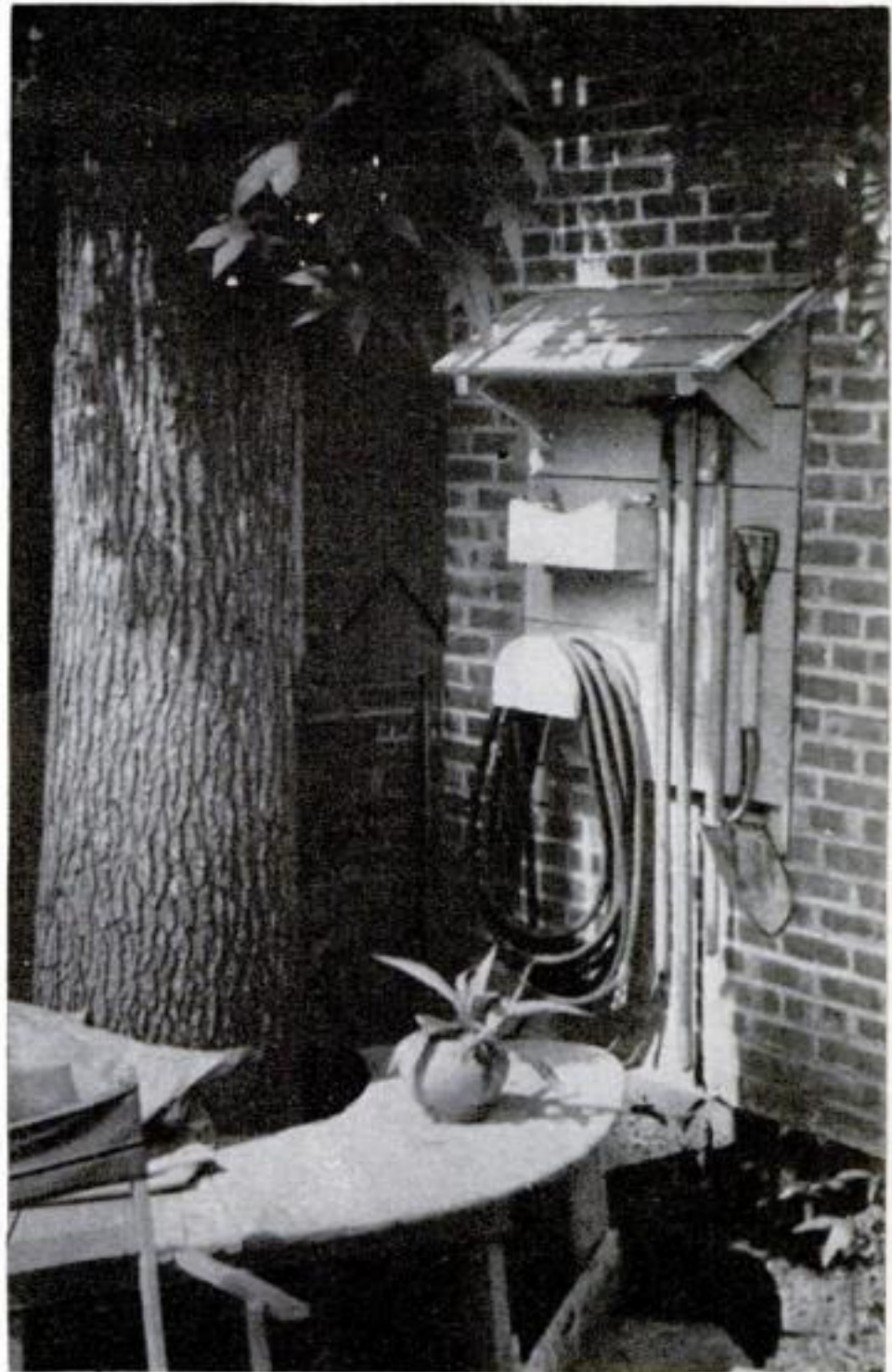
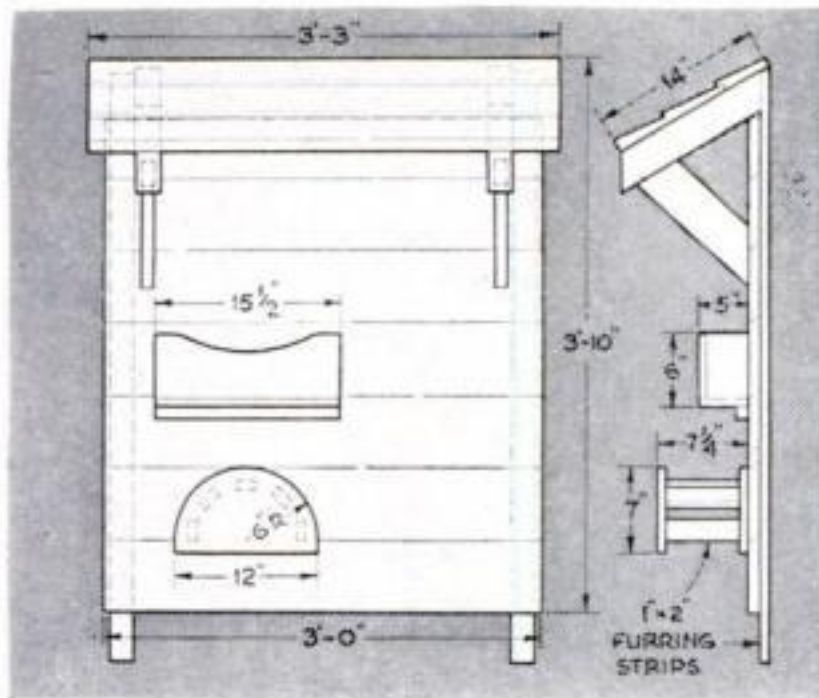
INSULATION CHART

Type of insulation	Thickness	Coefficient
Insulation between ceiling joists	2"	.045
" " " "	3"	.053
" " " "	4"	.058
Fill insulation inside walls		.035
Double or storm sash		.133

Attractive Rack for Garden Tools Helps Save Extra Steps

CONVENIENCE and an attractive appearance are features of this outdoor rack for garden tools and hose. A rack of this type will save the home gardener many extra steps during the months when tools are most frequently needed. It is not usually desirable to put the rack to year-round use, however, nor to install it where theft of the tools is a possibility.

Design your rack to hold the tools which you use most often; generally this will include a hoe, rake, cultivator, spade, hand trowel, clippers, and hose. If possible, locate the rack in the shade and close to the garden. The overhanging roof adds both weather protection for your tools and a decorative touch to the garden.—MICHELE DE SANTIS.



Cut steel nails are used to hold this rack to the brick wall. Expansion plugs can be used on stucco

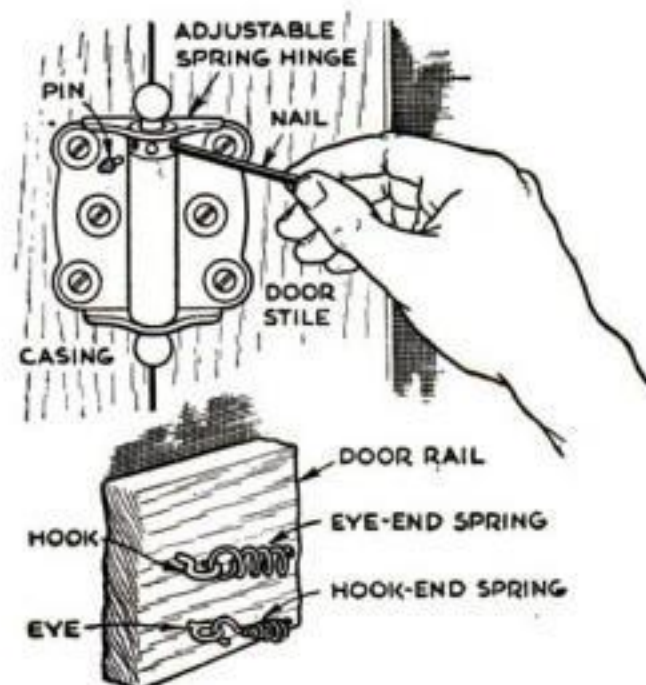
ADJUSTING SCREEN DOORS

[SHIPSHAPE HOME]

Screen and storm doors often do not close properly because their spring hinges lack the necessary tension. Hinges are adjustable for tension if they have holes around the collars. Insert a nail in a hole and turn the collar until the stop pin is freed. Replace the pin in a hole farther from the nail and allow the collar to turn back.

If the spring is broken or too weak, replace the hinge or install a screen spring inside the door, maintaining some tension even with the door closed. Be sure to turn the hook openings downward or inward to keep them from catching and tearing clothes.

A spring installed at the top of the door helps if the upper corner is sprung. To remedy the tendency of old doors to bow, install an inexpensive butt hinge at the center.

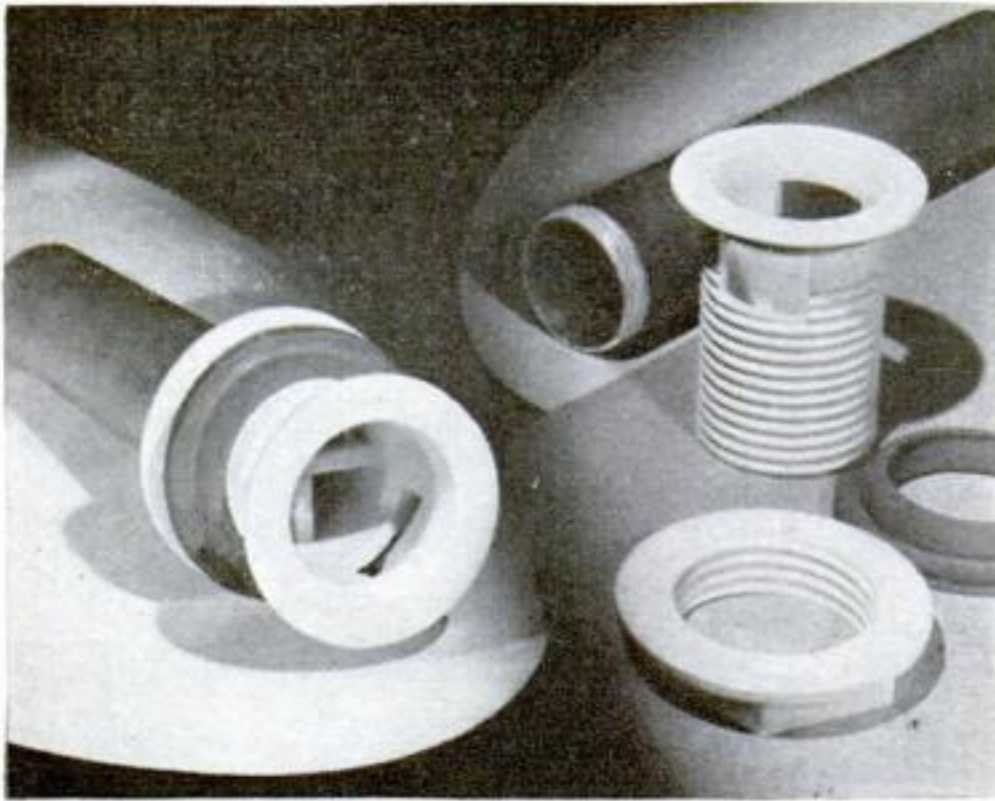


POPULAR SCIENCE MONTHLY SHOP DATA

OF INTEREST TO



HOME OWNERS



PLASTIC SINK DRAINS are now available to replace metal types. Made of a molded white plastic, the drains will not rust or corrode, and have no plated finish to wear away. The drain assembly consists of three units: a one-piece surface lip and drain, a rubber washer, and a plastic nut shaped to fit a standard wrench. The drain, which is easy to clean, can be quickly installed or removed for the repair of plumbing. An additional advantage is that it will not stain a porcelain sink.



SHATTERPROOF WINDOWS made of plastic and wire have been developed to protect workers in shell-loading plants from the danger of glass splinters. Unlike glass, this glazing material can be installed in window frames at the factory and shipped with little risk of breakage. Light in weight, the windows provide fair vision and excellent insulation. They are unaffected by changes in temperature or humidity, and can be cleaned by a cloth dampened with water or kerosene. Such windows are being used in prefabricated troop shelters overseas.



DEAD WEEDS and crab grass are the result if this liquid, properly diluted, is sprayed on lawns. Its makers assert the chemical causes no permanent injury to desirable grasses, and that it contains a nutrient that stimulates lawn growth. It can be used to spot out dandelions. Applied undiluted, it kills all growth on drives or tennis courts.

NONFADING PAINT for exterior trim, doors, and blinds is on the market. The paint (not shown) is made with pigment which is ground so fine that the particles remain in colloidal suspension in the vehicle. Since heavy fillers are not required to give covering power, the paint produces a gloss surface highly resistant to fading and weathering.

BUILDING BOARD constructed of noncritical asbestos and cement is helping to replace fiber, plywood, and sheet-metal materials that have gone to war. These new boards can be sawed, drilled, or nailed. Being entirely fireproof, they are excellent for making heating or ventilating ducts. Boards come in 4' by 8' size, and in 3/16", 1/4", and 3/8" thicknesses.



STARTERS of fluorescent lamps now have long operating lives. Shown above is a manual-reset type with an average rated life of three years. It is designed to lock out dead lamps quickly, eliminating flicker and reducing wear on both the ballast and starter. Below is a glow-type starter built to take hard punishment from a dead lamp and also to show long life in service.



OPAQUE GLASS SHOWER ENCLOSURES, designed to occupy space usually allotted to a bathtub, are being used in new housing. They are made of thick sheets of colored glass fabricated into a single unit, which can be used as a tub as well as a shower stall although the front is only 1' high. Developed primarily for low-cost war homes, they will fit in an alcove left vacant by the scarcity of bathtubs.

PORCELAIN OR CHINA repairs can be made with the kit pictured at the right. Glass, pottery, plumbing fixtures, and even piano keys may be refinished or cemented. The kit contains a cement compound for filling in any chipped area, and a porcelain glaze, which blends with and covers the repair. The materials are said not to shrink, craze, or crack. After the surface has hardened, it is impervious to the effects of water, alcohol, gasoline, or acids.





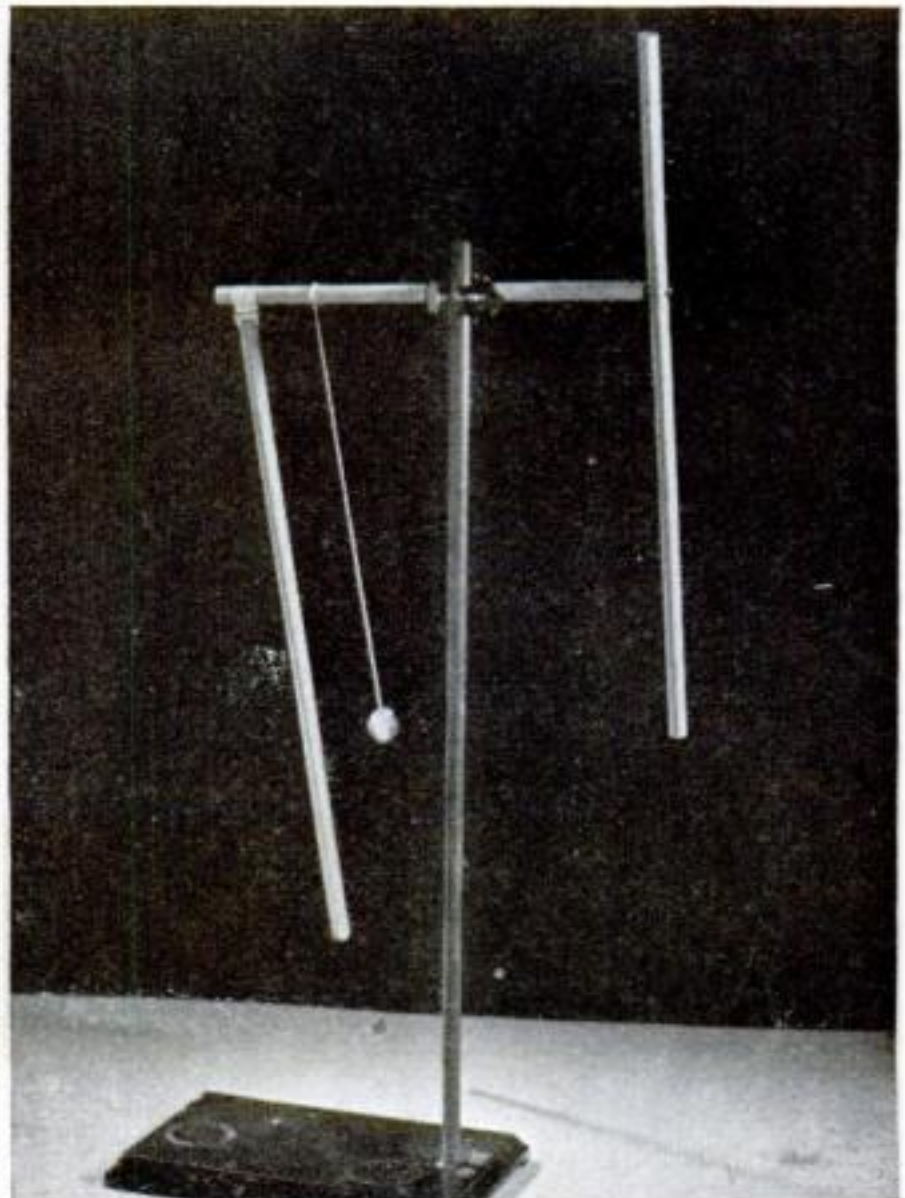
home EXPERIMENTS

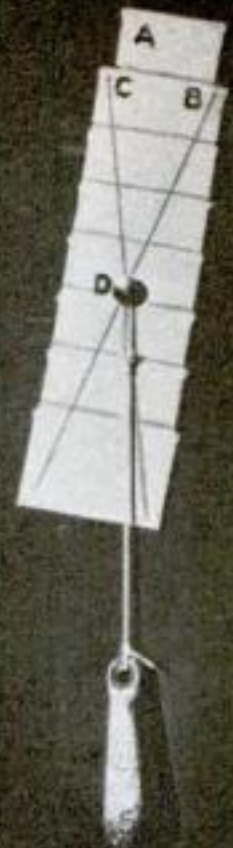
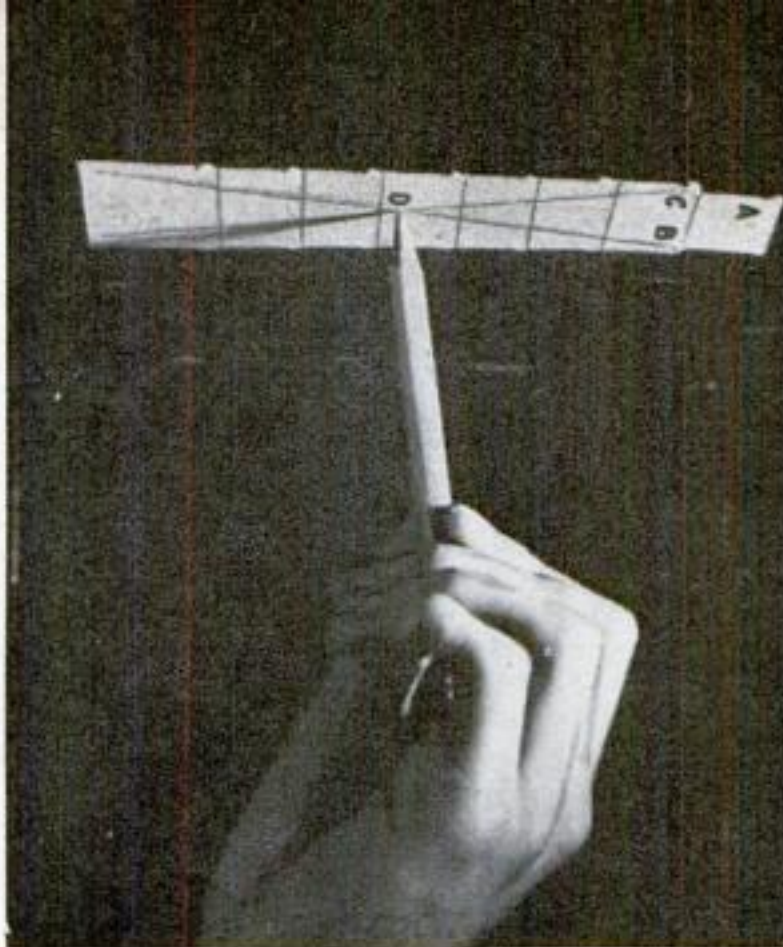
ARTILLERY FIRE. Computing the trajectory or path of a shell is complicated work for an artillery officer, but you can demonstrate the principle on your bridge table with two marbles and a hacksaw blade. Flip the blade as shown above, and the two marbles

will shoot off the table, the one closer to the stationary end of the blade a short distance, the other much farther—yet you can tell by the simultaneous clicks that both hit the floor the same instant. This seeming contradiction is due to the constant pull of gravity, which exerts the same force regardless of the motion of the object, even though it may have the speed of a bullet. The instant a bullet leaves the gun, gravity attracts it to the earth. One fired horizontally will hit level ground at the same instant as a bullet dropped simultaneously from the gun muzzle. In order to hit a distant target, artillerymen compensate for this by tilting up the muzzle.

THE MOTION OF A PENDULUM is produced by the constant acceleration of gravity. The time of each swing is directly proportionate to the square root of the length of the pendulum. To prove this, suspend a marble on a string and set it swinging. Time its swings with a watch. You will find that to make it swing in half the time, you must shorten the length of the string not to half, but to one fourth that of the original.

A SUSPENDED ROD is called a compound pendulum, for it acts like a series of weights strung end to end. Suspend a dowel from one end alongside a marble and adjust the string on the latter until both swing at the same rate. The string will be about two thirds the length of the dowel. Mark this point—the *center of oscillation*—on a dowel of like length, insert a pin, and suspend it alongside the others. All three pendulums will swing in unison.



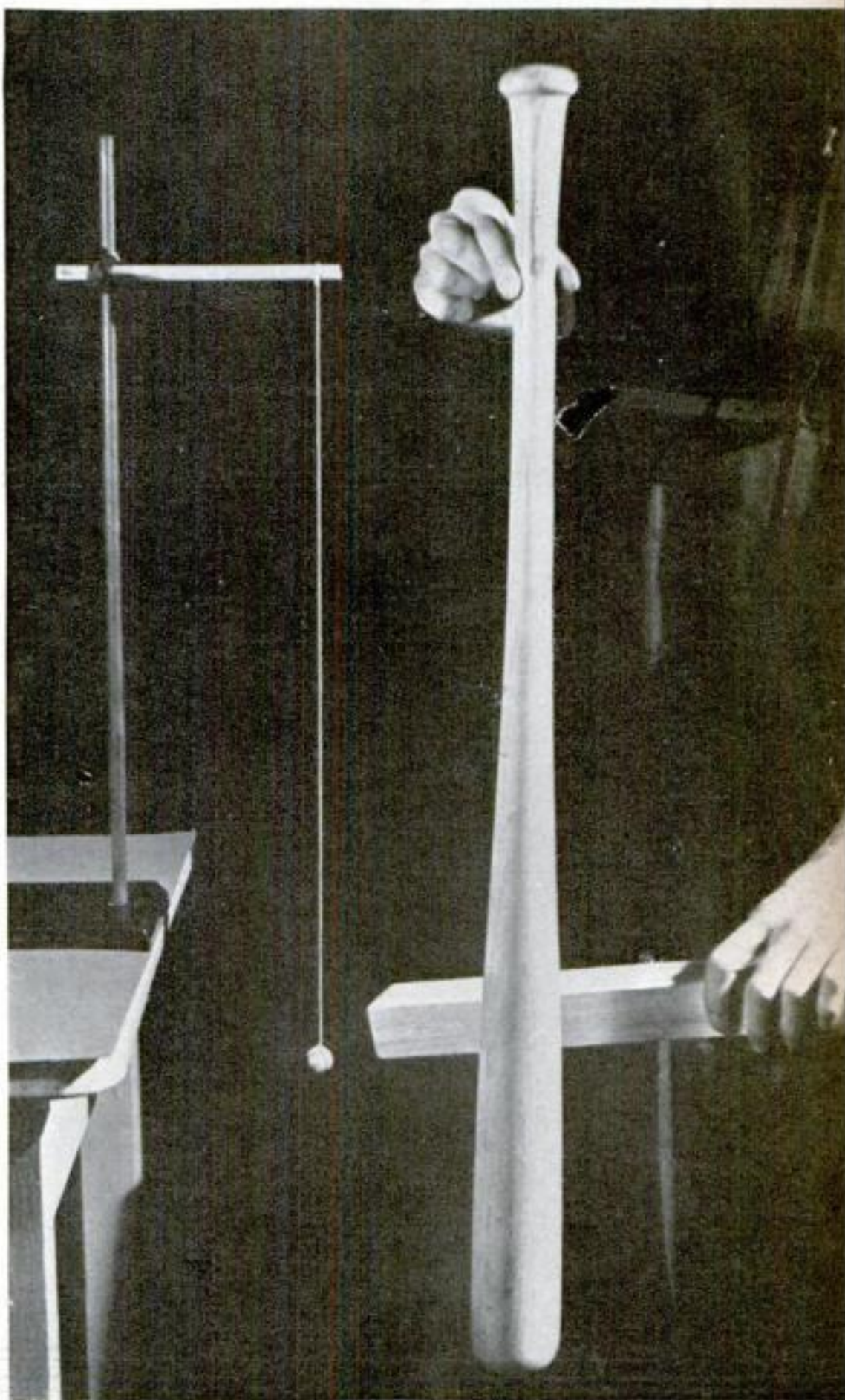


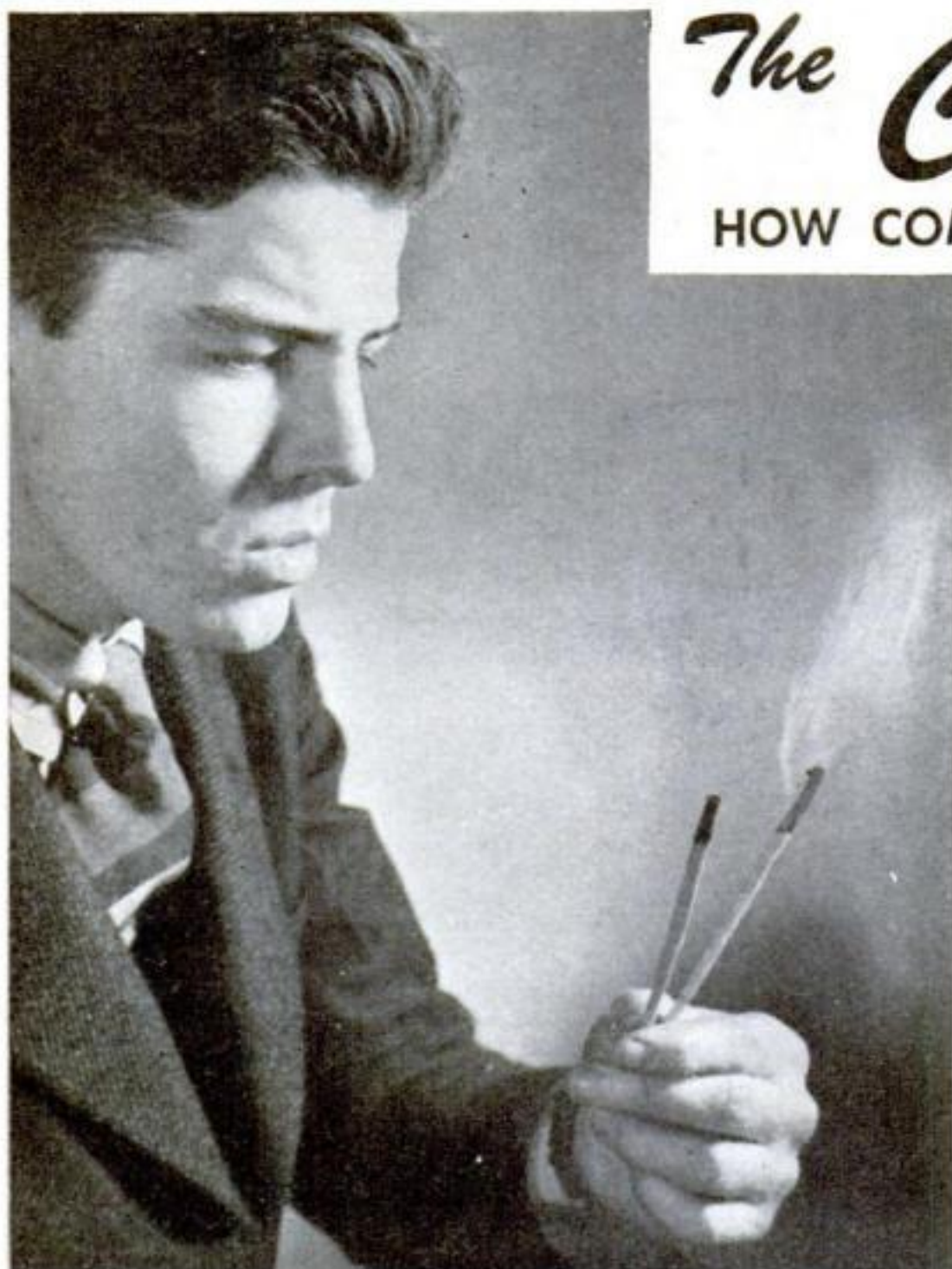
THE LEANING TOWER OF PISA

doesn't fall because its center of gravity is low. To show this, hang a cardboard cutout from a point *B* near the top. From there hang a weighted cord and mark its line on the model. Rehang from another point *C* and mark similarly. The intersection *D* is the center of gravity, as can be shown by hanging the cutout from point *A* (left, above).

If the lines are accurate, the model can be balanced at *D* on a pencil, as in the center photo above. If the cutout is pivoted at *D* and the plumb line also suspended from this point, the model may be tilted until the cord coincides with either pencil line without toppling over, as shown at the right. Because its base is proportionately heavier than that of the model, the Tower of Pisa could lean much further without falling.

WITH "BATTER UP!" Babe Ruth applied physics to every home run, for a swinging bat is a compound pendulum, and its center of oscillation is also its *center of percussion*. This is the point of most effective drive, and the one which imparts the least jar, with the least likelihood of splitting the bat. It can be located by allowing the bat to swing free 6" from the grip end and synchronizing the swing of a marble with it. The point on the bat opposite the marble is the center of percussion. Tapped there, the bat swings freely; struck elsewhere, it shudders and stings your hand. This same law of physics is applied in many hand tools, such as hammers and axes, and in machinery. For instance, if an ax handle is too long, the center of percussion may not be in its head, but farther up, in the handle. Such an ax shudders, and the handle may break.





The Chemistry

HOW COMMON CHEMICALS CAN

Below, several splints are soaked in a strong solution of alum. One so treated and another not treated are set alight together and then blown out, as at the left. The treated one is extinguished; the other continues to smolder



By Benjamin Taplitz

A SUPPOSEDLY extinguished match, still aflame and carelessly thrown where it falls on or against an inflammable object, may start a fire and cause a catastrophe that could have been avoided by forethought and simple fire-prevention aids. Although some fires start from inexplicable causes, many of them are preventable by chemical means that thwart disaster in the making.

You can easily prove the effects of chemicals in fire retarding by a few simple experiments in your home laboratory. After you have made the tests, you may want to treat certain inflammable objects in your home against the danger of accidental exposure to flame. The method is the same as given in the following experiments.

Take a small piece of unsized cloth—a well-washed and worn handkerchief will do—and tear it in half. Dip one of the pieces into a solution made up of 1 oz. borax crystals and $\frac{3}{4}$ oz. boric acid crystals dissolved in a pint of water. For a practical application, the cloth should be left in the solution for one hour, but for this experiment one or two minutes will be enough. After dipping

the cloth, allow it to dry out thoroughly.

Now fasten the two pieces of cloth to the ends of an improvised fork made from an old coat hanger, as shown in the photo at right, and hold them above the flames of two candles. The untreated piece of cloth will burn, while the treated piece will merely char. Many chemicals used in safeguarding fabrics against fire work in similar fashion. The cloth may not be kept from charring, but it will not burst into flame and spread the fire.

Although the solution just mentioned is cheap and easily made, the salts are both soluble and will be dissolved out when the fabric is washed. For materials that require repeated washing, a two-solution process is necessary. In one such treatment, a tin salt such as sodium stannate is precipitated directly into the fabric. This is accomplished by first dipping the material in a solution of 3 lb. sodium stannate in 1 gal. water. Follow this by wringing, drying, and then dipping the material in a second bath of

An ordinary piece of cloth blazes merrily, but the other, impregnated with a solution of borax and boric acid, merely chars. This flameproof treatment acts to retard the spreading of fire



of Fireproofing-

BE USED TO RENDER MANY SUBSTANCES FLAME RESISTANT

1¼ lb. ammonium sulphate dissolved in 1 gal. water. These treatments are suitable for curtains and cloth articles used near candles and lamps, and for party decorations that may be exposed to accidental contact with flame.

For heavy materials, such as awnings and canvas tarpaulins, the following double bath is recommended: First dip the fabric in a solution of 2 lb. ammonium phosphate in 1 gal. water. Allow it to dry; then dip it in a solution of 3 lb. alum in 2 gal. water. If the material is too unwieldy for dipping, the solution may be applied with a spray gun.

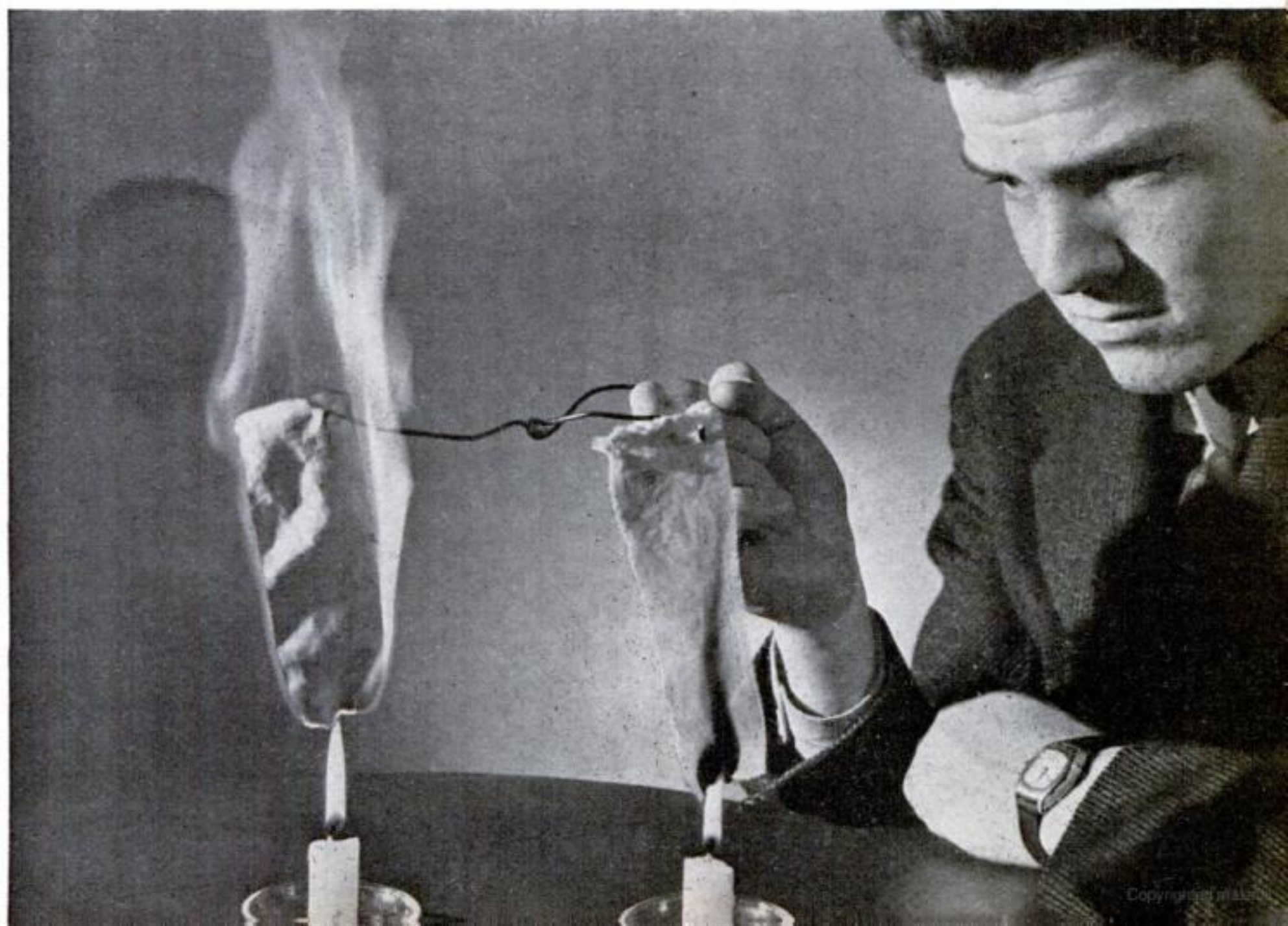
A new development in rendering fabrics fire resistant is a solution of ammonium sulphamate. The amazing fire-retarding qualities of this chemical were discovered just in time to make it of tremendous value to the armed forces.

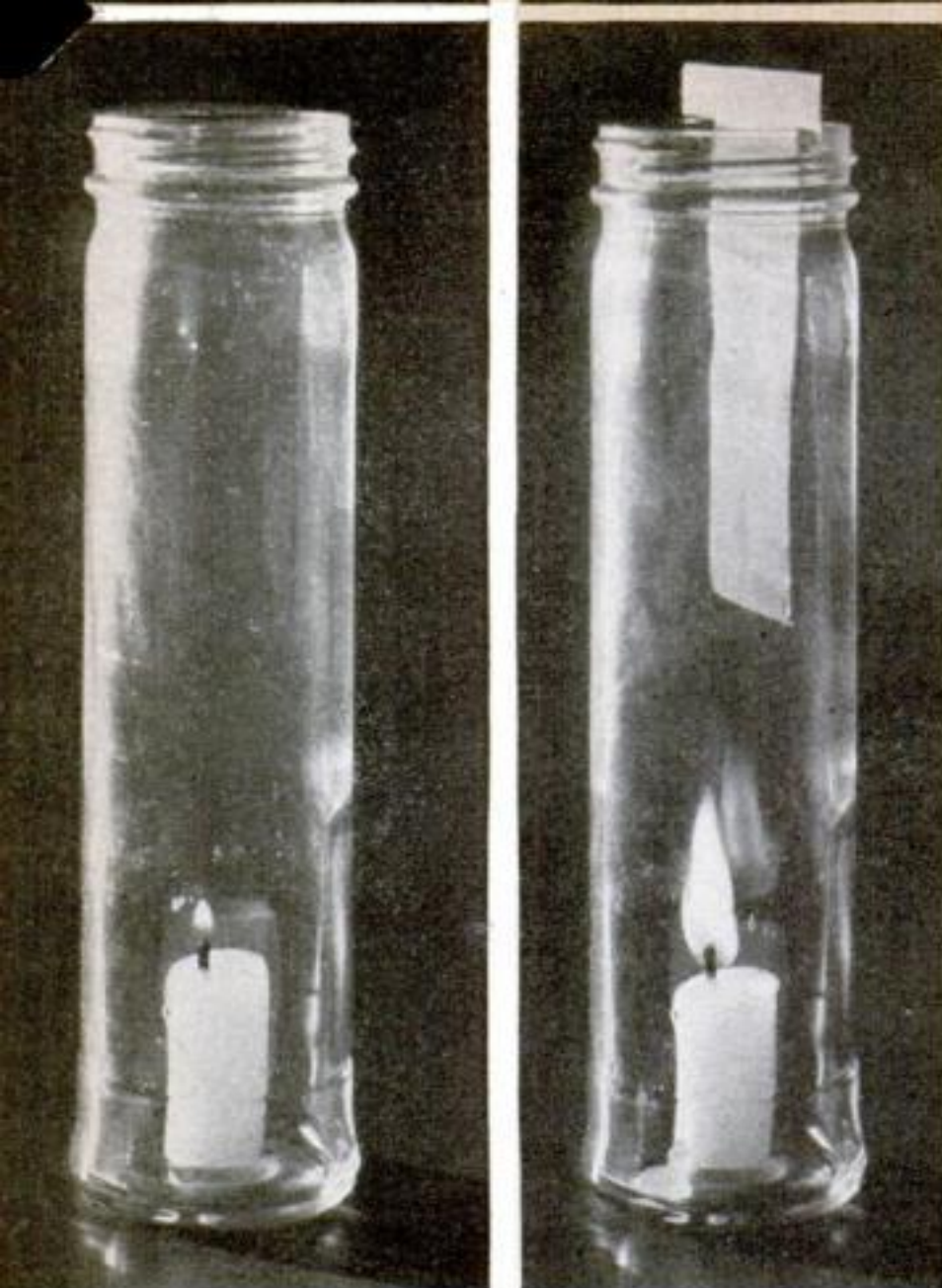
Chemical treatment of the wooden structural members of a frame house will reduce combustibility, and the construction of the walls themselves can be designed to act as

a hindrance to fire. For example, the open spaces between the studs should be sealed off from each other to prevent drafts and convection currents that feed a fire. The effect of a convection current on a flame can be demonstrated with a candle and a pickle jar. Light the candle and lower it into the jar, where it will burn feebly. Cover the jar mouth with your hand and the candle will be snuffed out. Now cut a T-shaped strip of metal that will extend down into the jar just clear of the flame. Hang the strip by the bar of the T and relight the candle, which will now burn brightly. The partition creates a convection current that feeds the flame with air, thus supporting combustion.

The chemical treatment of wood to retard combustion is accomplished by putting the wood in an air-lock chamber, removing the moisture from it by creating a near vacuum, and then forcing a treating solution, such as zinc chloride, into the wood under high pressure.

A solution made of 1 part commercial



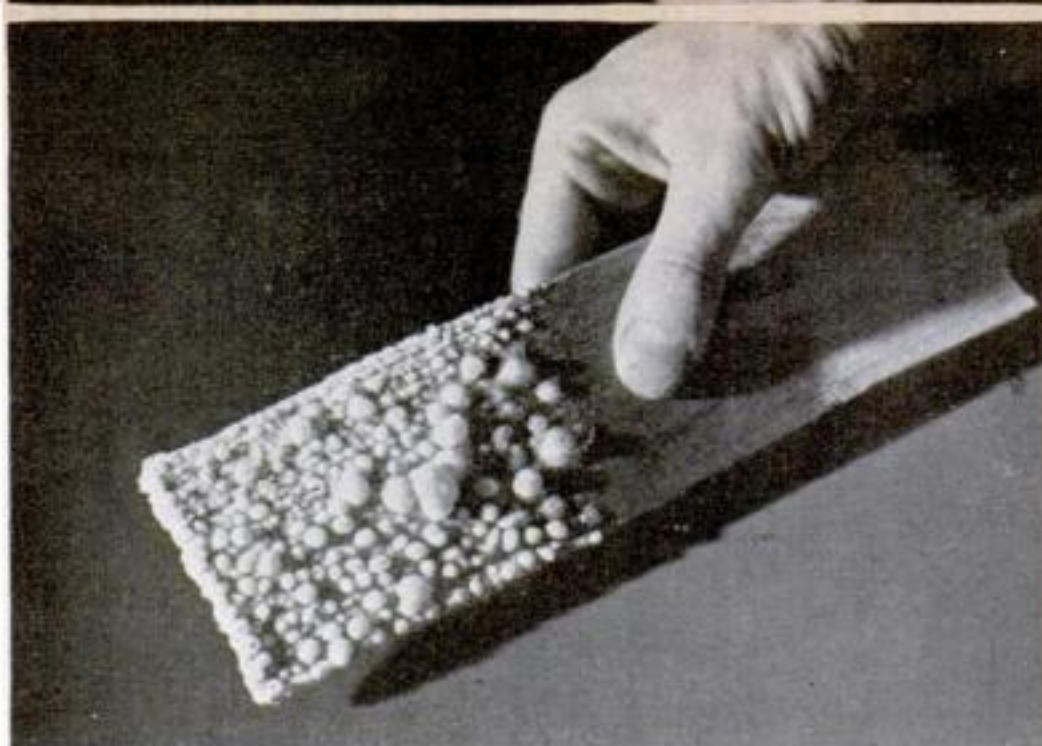


A candle in the jar at left above burns feebly, but a partition inserted in the top of the jar, as shown at right above, creates a convection current, causing the candle to burn brightly

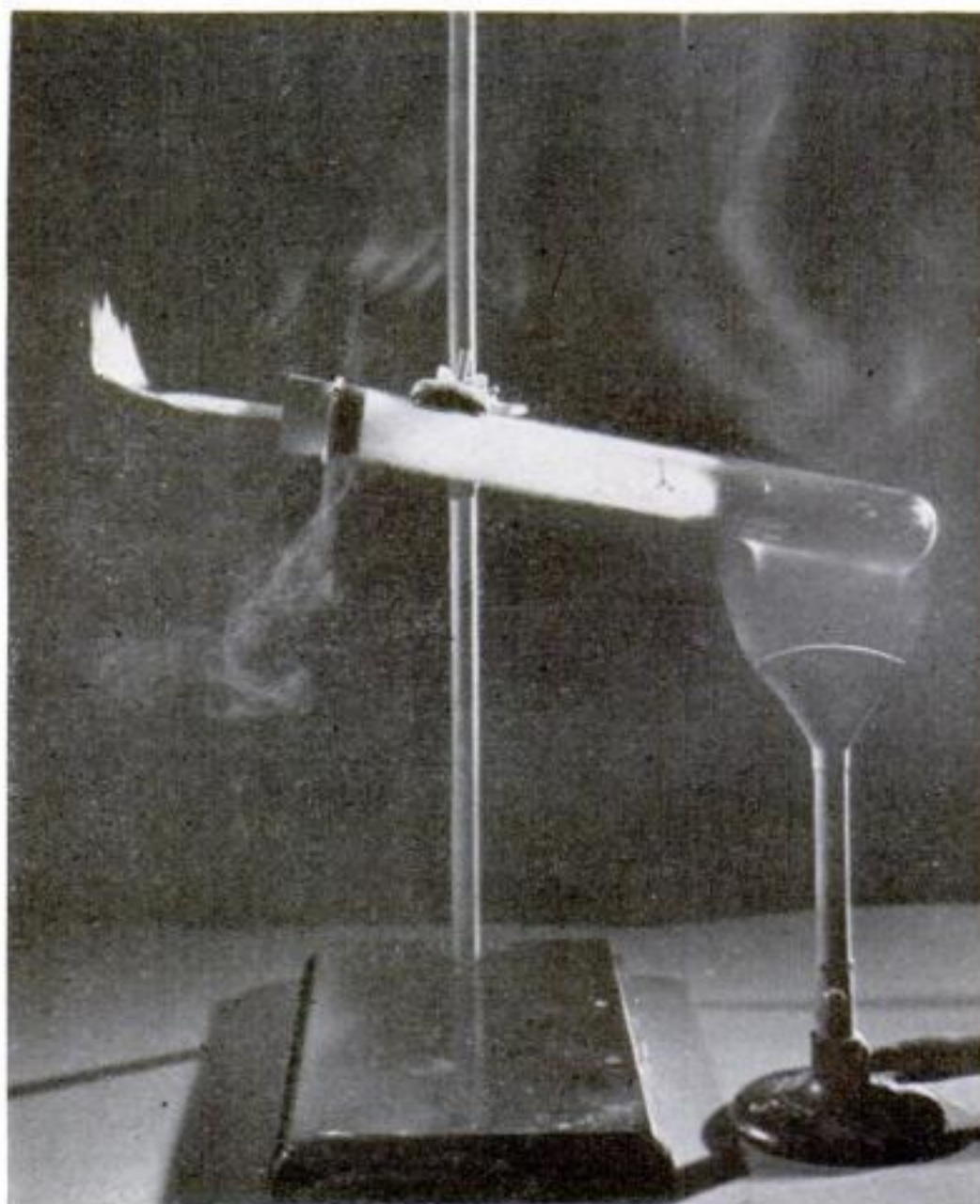
Right, wood shavings heated in a test tube give off combustible gases, which are shown blazing at the tip of a glass nozzle fitted in the cork

water glass to 2 parts water by volume has fire-retarding qualities. For studying the reaction of water glass to fire, paint a piece of wood with three coats of the solution, allowing each coat to dry before applying the next. When the last is thoroughly dry, hold the wood in the flame of a Bunsen burner. The coating swells to a frothy mass which hardens into a thick layer. It is the inert gases in this bubbly mass that insulate the wood against fire.

The chief requirement of a good fire-retarding agent is that it be noninflammable and form a protective coating that persists at high temperatures, or that produces, as a result of contact with high temperature, a noncombustible gas that will render ineffective the volatile, inflammable gas released from the wood. That such a gas is produced can be easily shown. Put a few wood shavings or sawdust in a glass test tube fitted with a stopper from which projects a glass tube drawn to a jet. Heat the tube in a Bunsen flame and, after a minute of heating, hold a lighted match to the smoke from the jet. The gas will burn.

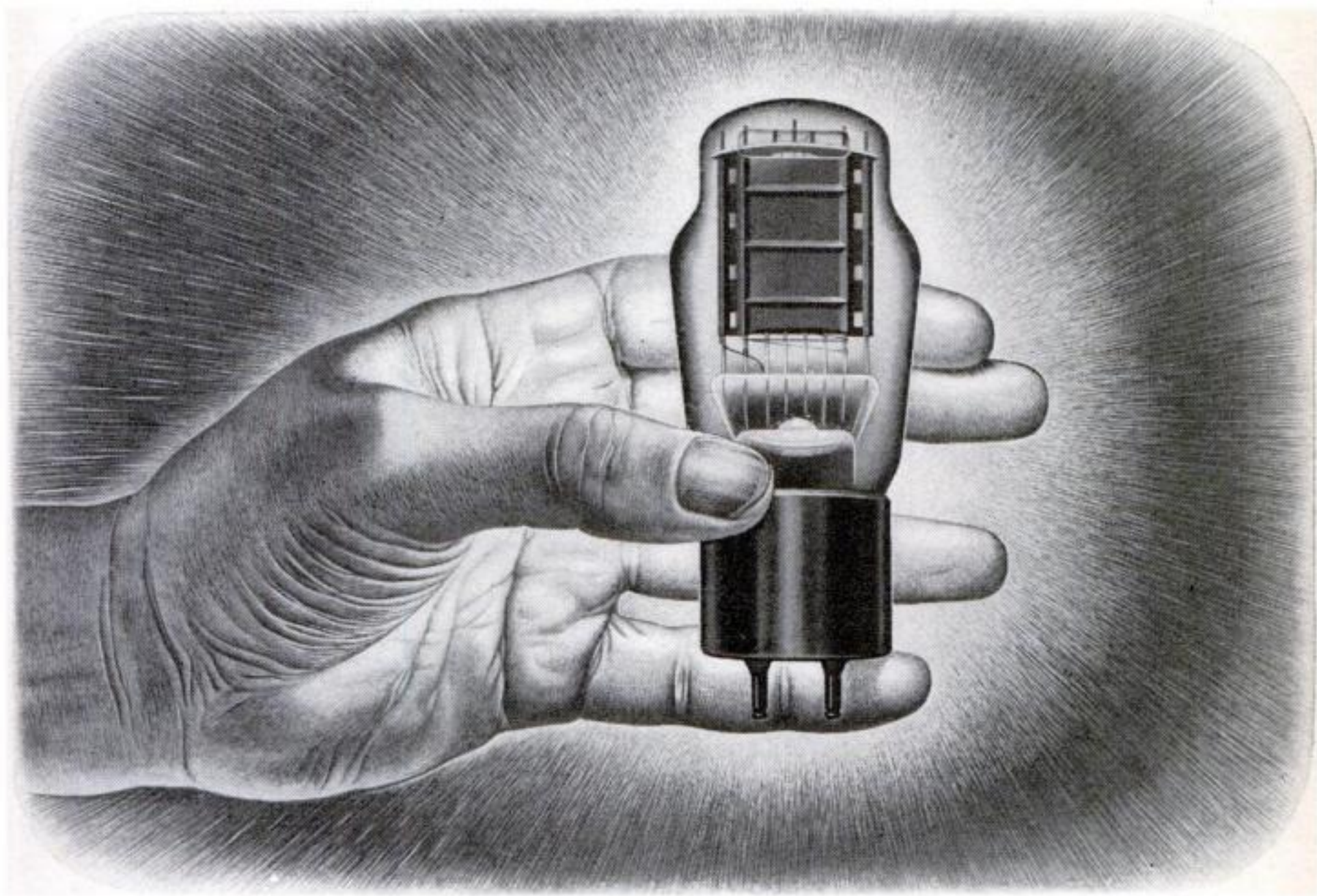


The photograph above shows the effect of a fire on a piece of wood treated with water glass. The mass of bubbles, each containing a minute amount of inert or noncombustible gases, forms an insulating wall that has a retarding effect upon combustion of the wood



Strange as it may seem, matches are chemically treated for fire resistance—not to keep them from burning, but to prevent afterglow. You may demonstrate this principle with two wooden splints. Soak one for a few minutes in a strong solution of alum. After drying it, hold both the treated and untreated splints in a flame. Both will burn. When you blow out the two flames, however, the treated splint goes out almost immediately, but the other continues to glow for some time.

"IT OUGHT TO GET A WAR MEDAL"



THIS little tube *can't* help you smell. But it *can* help you talk, see and hear. Right now, it helps direct guns, planes, ships. It ought to get a war medal.

It has given birth to a new art called Electronics.

In 1912, in the Bell Laboratories, Dr. H. D. Arnold made the first effective high-vacuum tube for amplifying electric currents.

Vacuum tubes made possible the first trans-oceanic telephone talk by the Bell System in 1915.

Vacuum tubes are now used on practically all Long Distance circuits to reinforce the human voice.

That's why you can talk across the continent so easily.

Over 1,250,000 electronic tubes are in service in the Bell System. Bell Laboratories developed them, Western Electric made them.

But both Laboratories and Western Electric are busy now with war — turning out tubes and putting them to work in many a device to find and destroy the enemy on land, in the air, and under the sea.

After the war, this Bell System army of tubes will work in thousands of ways for peace.

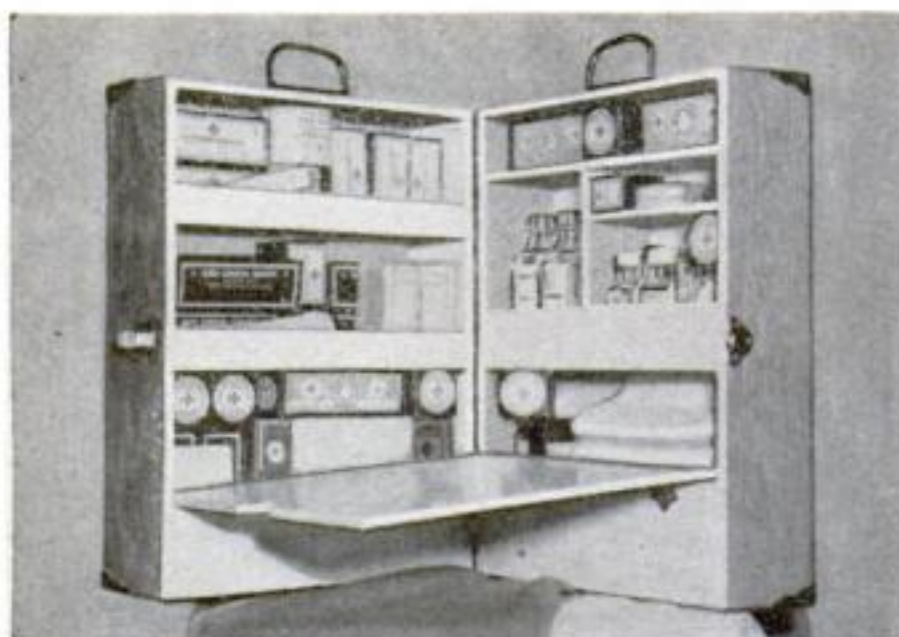
BELL TELEPHONE SYSTEM



HELP THE WAR BY MAKING ONLY VITAL CALLS TO WAR-BUSY CENTERS. THAT'S MORE AND MORE ESSENTIAL EVERY DAY.

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HW 507



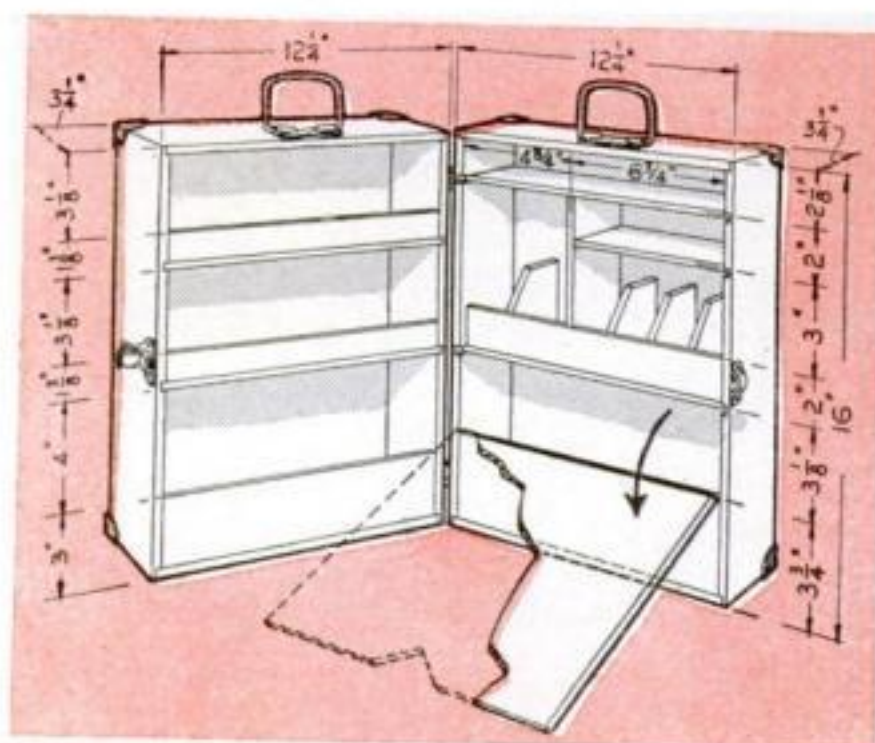
First-Aid Cabinet

THIS portable first-aid cabinet, used in Red Cross and civilian-defense ambulances, is arranged for quick, easy access to supplies and is strong enough to withstand rough handling.

The best method of construction is to build the box complete and then saw it into halves on a circular saw. The side and end joints should be rabbeted to make them both strong and dustproof. Partitions and inside boxes are then made to fit. Finger holes are bored in the fronts of the inside boxes to help in quick handling, and they also make possible a flush front. Hinges, handles, and fasteners are bolted on for strength. For first-aid material, consult the *First-Aid Handbook* published by the American Red Cross.—CHARLES HENRY HUNT.



Storage space in this first-aid carrying cabinet is designed to save time in getting at supplies. Above, it is being put to use by a Red Cross unit.



OCTOBER CHECK LIST

[SHIPSHAPE HOME]

1. Remove screens, repair, paint, and store them flat.
2. Clean window frames, metal screen hangers, and paint.
3. Fit storm windows and doors, adjust hangers and hinges.
4. Calk around all windows and door frames.
5. Sweep out eaves troughs and paint inside with protective paint.
6. Scrape out sidewalk cracks and fill with cement mortar.
7. Clean out and repoint cracks in outside masonry walls.
8. Insulate exposed plumbing pipes that might freeze.
9. Insulate warm-air ducts and furnace jacket.
10. Buy a supply of fuses and store near fuse box.

POPULAR SCIENCE MONTHLY SHOP DATA

A MESSAGE FOR THOSE ENTITLED TO BUY "PRESTONE" ANTI-FREEZE

The W.P.B. has tried to protect your needed equipment - have you?

THE WAR PRODUCTION BOARD has limited the sale of all-winter anti-freezes. This means that "Prestone" anti-freeze, the world's finest, is no longer available for use in passenger cars, station wagons or taxis.

The purpose was to reserve the remaining supply to protect the tools needed for America's war-time production and commercial transportation.

To you who are eligible for "Prestone" anti-freeze we say:

The W. P. B. has acted to protect your equipment. Have you?

In time of war, supplies of anything are unpredictable. No better way of assuring yourself of this vital winter protection than by laying in your next winter's supply right now!

**SAME PRODUCT
AS ALWAYS**

**SAME AS
LAST YEAR**

O. P. A. Retail Ceiling Price

\$2.65
per gallon



• WHO CAN BUY "PRESTONE" ANTI-FREEZE

As of the date this advertisement goes to press, you are entitled to buy "Prestone" Anti-freeze for use in essential equipment as listed below:

TRUCKS	DELIVERY CARS	AIR
BUSSES	STATIONARY	COMPRESSORS
TRACTORS	ENGINES	BULLDOZERS
SNOW PLOWS	GASOLINE SHOVELS	ETC.

**CAN'T EVAPORATE OR BOIL AWAY
PROTECTS AGAINST RUST AND CORROSION
ONE SHOT LASTS ALL WINTER—YOU'RE SAFE AND YOU KNOW IT!**

The words "Eveready" and "Prestone" are registered trade-marks of National Carbon Company, Inc.
Unit of Union Carbide and Carbon Corporation



PRESTONE ANTI-FREEZE

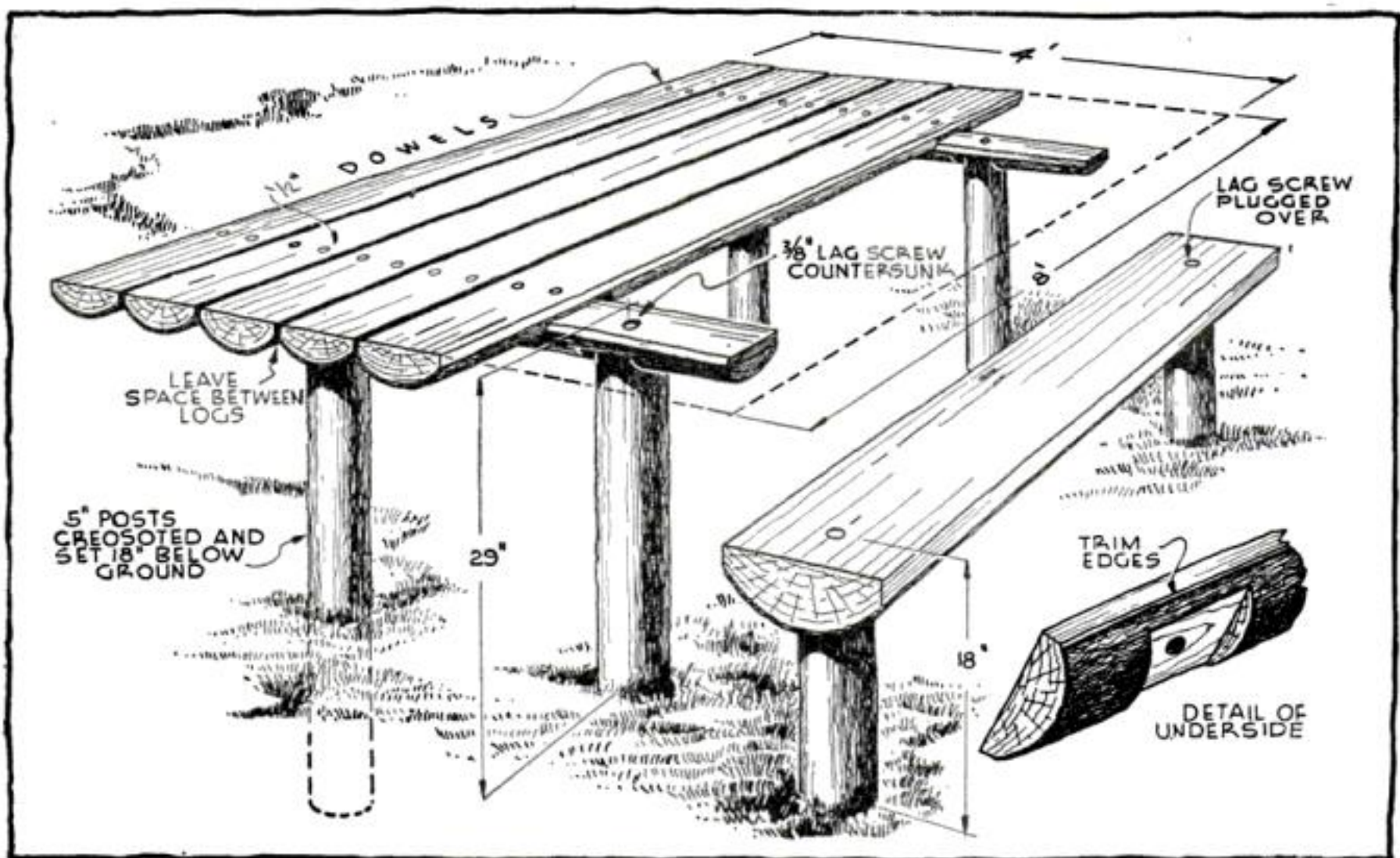
TRADE-MARK

BUY WAR BONDS AND STAMPS

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HW 509

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Puncheon Table Adds Rustic Touch to Back-Yard Barbecues

THE most satisfactory tables for outdoor use are heavy ones, and as they are seldom moved about, they might as well be permanently located, provided they are weather-proof. Here is one that will take as much weather as a slate roof—and like it.

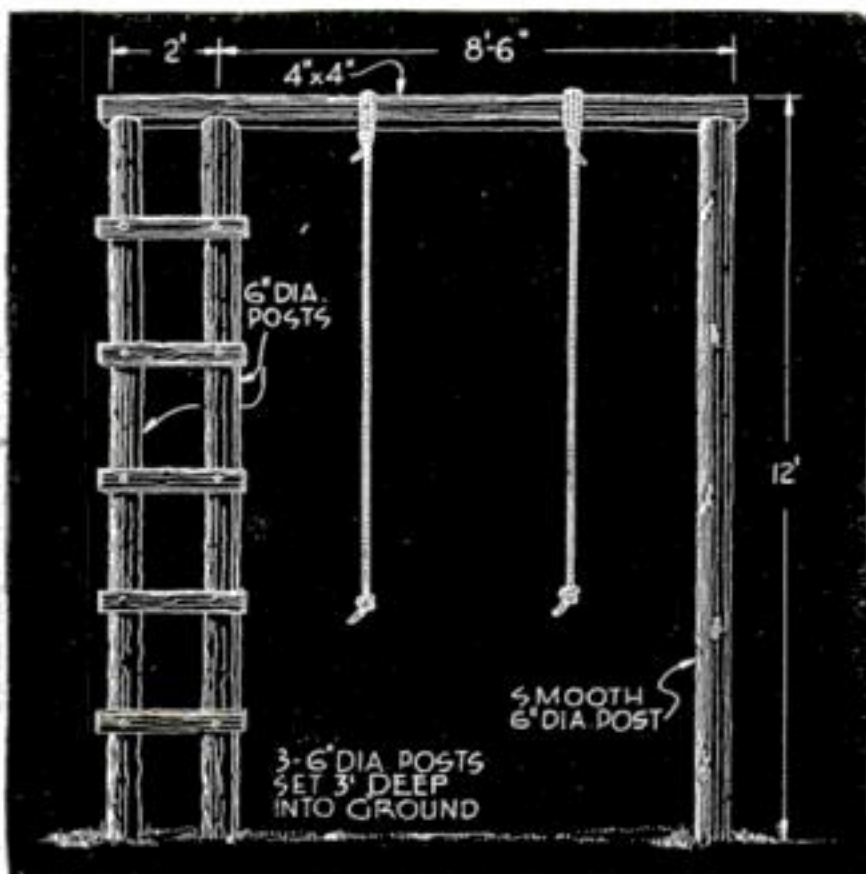
If you live in timber country, you can probably buy split logs at a local mill. Elsewhere, you can shape them yourself with a crosscut saw and an adz, which produces an interesting hand-hewn effect.

The table should be about 29" high. Set the supporting posts 18" deep after creosoting the ends for slightly more than this.

Notch the cross members and fasten them with countersunk lag screws.

Puncheons for the table top should also be notched on the undersides and trimmed fairly straight along the edges, but need not fit snugly together. It is better to leave about $\frac{1}{4}$ " between them so that rain and melting snow may drain off. Fasten them with $\frac{1}{2}$ " dowels to the cross members.

Set the bench posts to bring the top 18" above the ground. Notch a larger split log for the seat, and secure it to the posts with lag screws, countersinking these well and plugging the holes with dowels.—HI SIBLEY.



Outdoor Gym Unit Trains Boys

PHYSICAL fitness programs for high-school boys suggested this outdoor gymnasium unit designed especially for developing arm and shoulder muscles.

Three durable posts about 16' long and 6" in diameter are first set securely in concrete. A 4" by 4" piece of lumber to support the combined weights of several husky boys is spiked across the tops of these. The climbing ropes should be at least 1" in diameter to provide a firm grip. The crosspieces that form the ladder are nailed 2' apart so that boys can practice climbing in and out between them as they advance to the top.

Since the post at the other end is designed to be used as a climbing pole, it should be smoothed carefully as insurance against any splinter hazard.—GEORGE A. SMITH.



HE NEVER saw a Jap plane in his life. Never handled a weapon deadlier than a BB gun. He'll never make the headlines or the history books.

But he works in a plant back home that makes precision instruments. And when the target's a Zero moving at more than 300 miles an hour, anti-aircraft marksmanship is an instrument job. Hit or miss—it depends on him!

Precision instruments count heavily in *every* action in this war, are needed in unprecedented numbers.

This is especially true of optical instruments, which Universal now makes for the Army, Navy, Marines and United Nations, in *quantity production* hitherto thought impossible where present high standards of precision are so vital.

Today, thanks largely to Universal engineering research, outstanding accuracy in lens-making is achieved more economically than ever before, anywhere in the world.

Result: A new impetus in the development of photographic and optical instruments—promise of finer-than-ever cameras available to everyone.



TEST FOR A PERFECT MARRIAGE

A binocular is really two instruments fastened together, one for each eye. They must be exactly aligned so that both eyes can see as one. Here is one of hundreds of tests for binoculars at the Universal Camera Corporation plant—making sure that the two instruments have become one instrument of highest precision in a perfect marriage!



There's only one flag
we're prouder of!

UNIVERSAL CAMERA CORPORATION

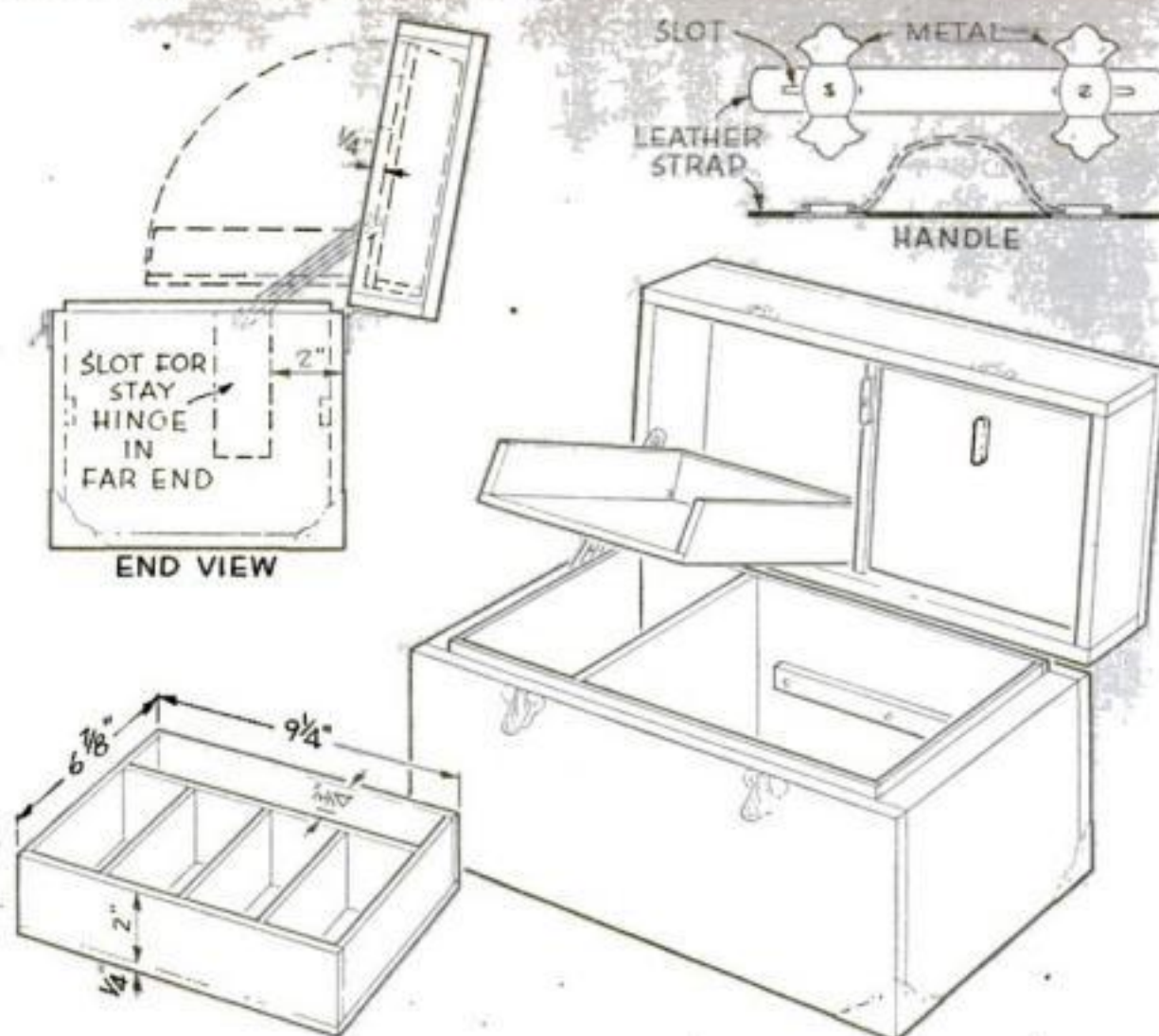
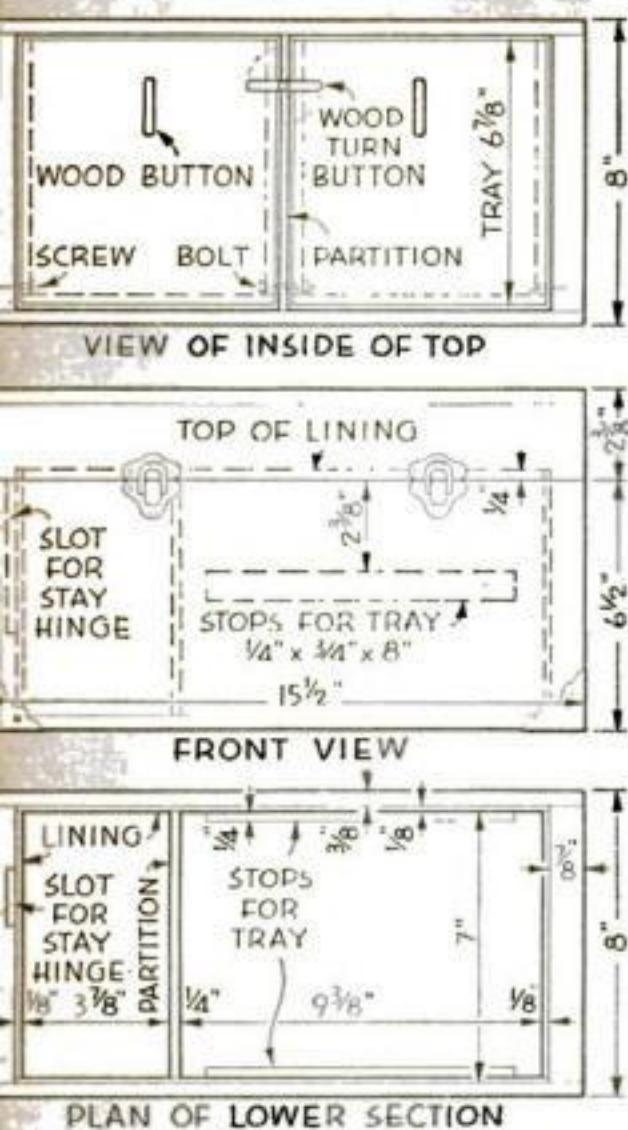
NEW YORK • CHICAGO • HOLLYWOOD

Makers of Precision Photographic and Optical Instruments • Peacetime Manufacturers of Cinémaster, Mercury, Corsair Cameras

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HW 511

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Durable Wooden Tackle Box

SCRAPS of wood from larger projects will do for building this sturdy tackle box. Use $\frac{7}{8}$ " stock for the ends, $\frac{3}{8}$ " plywood for the sides, top, and bottom, and $\frac{1}{4}$ " stock for partitions. A lining of $\frac{1}{8}$ " composition board extending up $\frac{1}{4}$ " from the bottom section on the sides and ends creates a watertight joint when the lid is closed.

Make the box $\frac{1}{8}$ " higher than dimensioned, put marine glue in all the joints, and fasten the sides, top, and bottom together

with screws. Then bandsaw the box apart $2\frac{3}{8}$ " from one side. The two hinged drawers pivot on screws in each side as well as on a bolt set into the center lid partition. One drawer is slightly narrower to allow space for the stay hinge.

Finish the box both inside and out with waterproof varnish. Brass corners, a handle, and catches from an old suitcase will serve for fittings. The handle should lie flat when not in use.—HARRY W. WANNER.

THE SHEET BEND

[KNOTS]



The sheet bend, or weaver's knot as it is sometimes called, is a simple, safe way of joining two ropes or straps together, especially when they are of unequal size. The knot does not slip out of place, yet is very easy to untie.

Hold the larger rope in the left hand and cross it over the smaller rope, holding both at the crossing point with the forefinger and thumb of the left hand (Fig. 1). With

the right hand grasp the lower part of the smaller rope and loop it clockwise around its own end (Fig. 2). The end of the larger rope is then threaded through the loop so formed, as in Fig. 3, and the ropes are drawn taut to complete the knot (Fig. 4).

The sheet bend is easily released by pressing down on the bight of the larger rope, which is indicated by an arrow in Fig. 4.

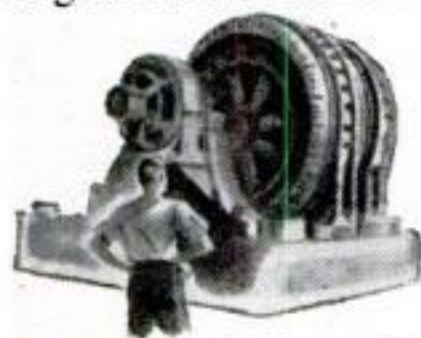
POPULAR SCIENCE MONTHLY SHOP DATA

"HARD WORK NEVER HURT ANYBODY"

The
Story of
Harry A. Winne

A BOY waving at the trains passing in and out of his world—enchanted by the mystery of their engines and machinery—that was Harry A. Winne.

He just *had* to know what made their wheels go round, and he was about knee-high to a brakeman when he started to learn. He'd hurry home from school to run the steam engine in his father's laundry. Soon he tore a



small magneto apart and from it built an electric motor.

He knew he was going into the electrical business somehow; he thought maybe he'd

become a lineman for an electric power company. So he and a blacksmith made metal climbers, and he learned to climb the telephone poles outside the grocery store where he was clerking.

But the teachers in the upstate New York town urged him to go to Syracuse University to study engineering. So Harry Winne started working harder. Summers he worked in a creamery; at other times he delivered the college newspaper and was Sunday watchman at Woolworth's. Studying as hard as he worked, he was graduated at the head of his engineering class in 1910.

At once he joined General Electric as a student engineer in the testing department, Schenectady. There he could watch some of the biggest wheels in the world go round, and

in two years he was made assistant general night foreman.

"There are things higher up for you, Harry," his boss said before long. "You've got everything you can get here. You're destined for higher things."

And up Harry Winne went—through various engineering departments, to head of the steel mill section in G.E.'s industrial engineering department, to manager of sales of the combined mining and steel mill section—and then finally, a couple of years ago, to vice president in charge of design engineering!



Harry Winne'd tell you he got up there by hard work and luck. Today he's working harder than ever—at G.E. supervising the design of electric equipment for the army and

Navy, at home in a big Victory garden beside his made-over farm house on a dirt road outside Schenectady.

But then—"hard work never hurt anybody!" *General Electric, Schenectady, N. Y.*

Hear the General Electric radio programs: "The Hour of Charm" Sunday 10 p.m. EWT, NBC—"The World Today" news, every weekday 6:45 p.m. EWT, CBS.

The best investment in the world is in this country's future—BUY WAR BONDS.

GENERAL ELECTRIC

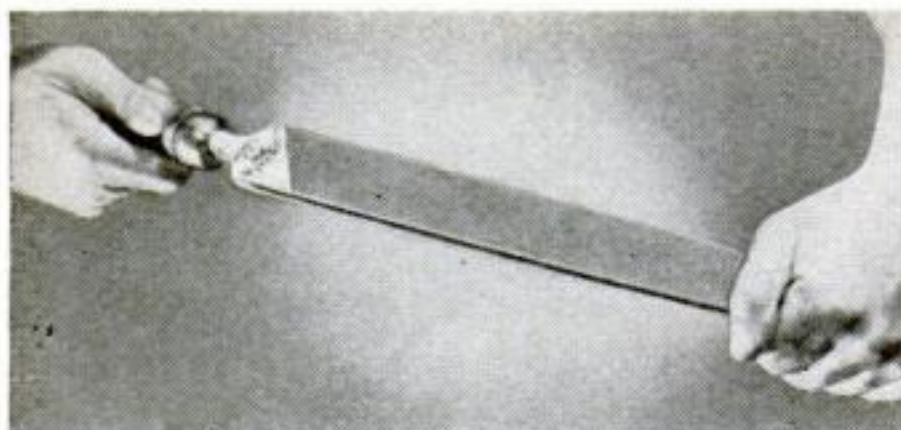
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OCTOBER, 1943

Buy War Saving Bonds and Stamps regularly.

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ITS BIG TEETH HAVE LITTLE TEETH



Micrograph enlargement of serrated teeth of coarse double-cut file.

AN ODDITY? You might call it that. But in *serrated tooth* construction, Nicholson has demonstrated that even in such centuries-old implements as files, engineering science keeps finding new things to keep pace with industry's march.

Besides greatly increasing filing speed, *serrated* teeth virtually give Nicholson or Black Diamond files "second wind." As each "little" tooth wears down, another brings up a fresh cutting edge. Result: longer efficient file life; a greater number of effective strokes per file; more work per worker; more filing production at less cost.

Through four generations of file-making experience, Nicholson has contributed many advancements. . . . In improved file designs. In faster and more accurate methods of cutting file teeth. And in thoroughly controlling every step of manufacture. Whether you buy one or a thousand, you'll find these famous files so uniformly made and hardened that Nicholson can guarantee "*Twelve perfect files in every dozen.*"

FREE BOOK, "FILE PHILOSOPHY"—The most authoritative and interesting book of its kind . . . 48 illustrated pages on many kinds of regular and special purpose files; use and care of files—with additional information of inestimable value to purchasing and production heads, foremen, key mechanics, farmers, repairmen. *Send for your copy.*

NICHOLSON FILE CO., 19 Acorn St., Providence 1, R. I., U. S. A.
(Also Canadian Plant, Port Hope, Ont.)

NICHOLSON
FILES FOR EVERY
PURPOSE



Nightmares for Hitler

(Continued from page 77)

cations of it to war matériel are hush-hush subjects of test at the Army and Navy proving grounds.

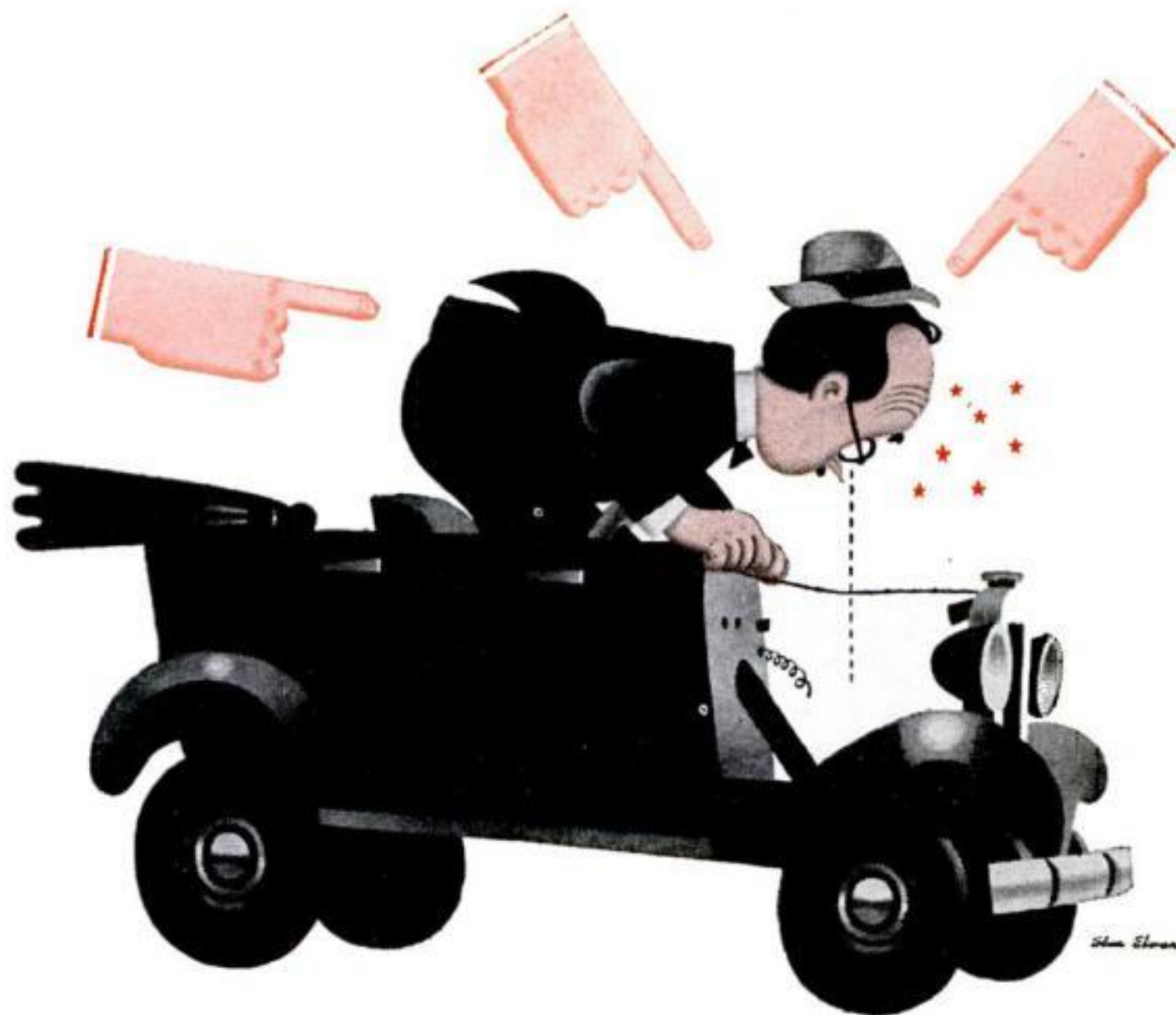
Another of the Unholy Ten—Berlin papers, please copy—who have been giving Hitler frightful nightmares is a former music teacher. The day after Pearl Harbor, Herbert Rudolph James turned over his class of music pupils to another teacher and took a job as a steel-mill worker at the National Tube Company, McKeesport, Pa. His boss tried to teach Herbert James how to weld tungsten carbide tips on big shell-turning tools. But, frankly, Herb thought his boss turned out a lousy job, for a little while after the expensive tip had been welded to the tool shank, the shell-lathe hand came back with it—broken at the weld.

At that point Herb took off on his first solo flight as a war-production idea man. He rigged up an iron-pipe frame and clamped three acetylene torches to it so that the flame from each would play directly on the tool. Then with all three torches going, he thrust a tool shank and tungsten carbide tip into this atmosphere of incandescent gas—and out came a perfectly welded tool that outlasted the single-torch-welded tool several times. The same result could have been obtained from an atmosphere-controlled electric furnace, sure. But such furnaces were not available. So, another spook under the bed at Berchtesgaden.

Out at the Packard Motor Car Company, 27-year-old George Smolarek one day took a series of operations laid out by the Packard professional engineers and telescoped three of those operations on a British Rolls-Royce airplane-engine part into one operation. It's a crime how many times since George Smolarek pulled that idea out of his cap those Packard-built Rolls-Royce engines have plastered the daylights out of the German Luftwaffe.

Yes, an idea can kill farther than a bullet. Stanley Crawford, a sharpshooting raw-material inspector at the RCA Camden, N. J., plant, saw entirely too many castings being junked because the cored interior was not in proper relation to the outside surfaces. This trouble was caused by the cores floating after the hot metal was poured into the molds at the foundry. Such castings failed to clean up in subsequent machining operations, at a great loss in both material and priceless man-hours. Crawford designed a special type of calipering gauge which determines the relationship between the in-

(Continued on page 204)



Guilty... OF ENGINE NEGLECT

THE finger of guilt points at the car owner who lets an automobile engine wear unduly for lack of the proper care.

Your car is a vital unit in our transportation system. Of course, tires and gasoline must be conserved, but *save that engine, too!*

Piston rings are a mighty important

factor in prolonging the life of your engine. At the first sign of ring wear, visit your motor service man and ask him to install a set of Hastings Steel-Vent piston rings. They restore engine performance, stop oil-pumping, save gasoline and check wear on cylinder walls.

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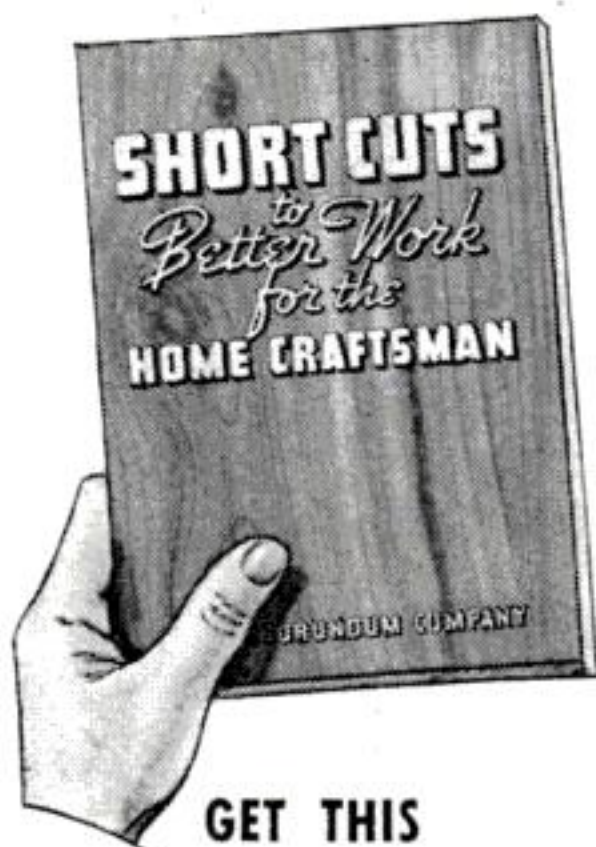
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Nightmares for Hitler

(Continued from page 202)

side and outside surfaces of a casting, enabling the machine operator to "favor" any shifting of the core. By the use of this caliper, 13 out of the 16 castings formerly rejected in raw-material inspection, or junked on the machine line, are now saved. Just that much more Yankee hardware headed Hitler's way.

The man who has probably caused more "talk" than any other Yankee mechanic in this war is Madison E. Butler, an assistant chief inspector of Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y. He was assigned to the job of testing field-telephone switchboards. When the first board came off the line, it took Butler and an assistant five whole days, with plenty of overtime, to check its maze of circuits. And there were 1,100 more following closely on its heels!

When Butler joined the Unholy Ten who were called to the White House and congratulated for their individual contributions to the hell-for-leather drive to manufacture more nightmares for the Nazis, this is how his citation read: "You have earned this high honor by developing an automatic lamp-indicator for testing Army field-telephone switchboards, thereby saving 11,000 man-days." Figure that out and it amounts to almost enough men to form a streamlined mechanized division for one day of battle. In other words, Butler came to bat with a foxy test rig with which one man could do a better job of testing a switchboard in less than two hours, compared to the original testing time of two men sweating out overtime for two days.

Meanwhile, the great American pastime of manufacturing nightmares to order for Hitler and his chums goes on. The records of the Production Idea Exchange Branch of War Production Drive Headquarters, the official agency of the War Production Board charged with the job of digging out these unsung heroes of the Production Front and plowing their ideas back into all possible war production channels, shows that well over 100,000 smart Yankee production ideas have been pulled out of the hats of American war workers. An impressive percentage of these ideas have been outstanding, such as the ten described in this article. More are turning up every day.

Is it any wonder that the man who could sleep like a baby with the murders of millions of innocent victims on his conscience now is having the heebie-jeebies every night when he pulls the covers over his ears?

Finger Man - AT MIDWAY



To avoid the possibility of giving information to the enemy, illustration of the Torpedo Director, intended for this space, has been omitted.

NEVER had aircraft done more damage to warships than U. S. torpedo bombers did in the great Battle of Midway. Some of the credit belongs to the torpedo directors which enabled our fliers to "put the finger" on the enemy.

Torpedo directors are accurate because they are made with extreme precision, and kept in condition by trained technicians.

Trained Technician Service Awaits YOU

America's automotive repair men are *your* trained technicians. They can give your spark plugs the cleaning and adjusting they must have. They can also give expert service on the eight other AC products with which millions of vehicles are equipped. Thus, these men can help you conserve gasoline, oil, and tires.

Take a minute, won't you, to read the few details (below) of the care your AC products should receive? When replacement becomes necessary, select AC—and be sure of complete satisfaction.



Awarded to AC on September 2, 1942, and renewed on June 19, 1943, for outstanding achievement in producing for Victory.

AC SPARK PLUG DIVISION — GENERAL MOTORS CORPORATION



TORPEDO DIRECTOR

AUTOMOTIVE SPARK PLUG



SPARK PLUGS



SPARK PLUGS—Dirty or worn plugs waste as much gas as one coupon in ten. Oxide coating collects on the plugs and causes them to misfire,—especially when the engine is working hard. Dirty plugs also cause hard starting which weakens your battery. Under present slow driving conditions, have your plugs cleaned and adjusted every few months.



AIR CLEANERS—A dirty air cleaner increases gasoline consumption because it chokes down the flow of air into the carburetor. Your air cleaner should be rinsed whenever your car is lubricated.



FUEL PUMPS—Practically trouble-free. But, if yours has been in use thirty or forty thousand miles, it

may be worn to the point where a check-up is due.



DRIVING INSTRUMENTS—Speedometer, gasoline gauge, oil pressure gauge, ammeter, and temperature gauge seldom need service. But, if they give trouble, have them cared for at once.



OIL FILTERS—Slow driving accelerates formation of soot and carbon in engine oil. If not constantly filtered from the oil, this dirt will clog piston rings, cause increased consumption of oil and gas. So, replace your oil filter element whenever your dealer's AC Oil Test Pad shows that your oil is dirty.

BRING VICTORY QUICKER — BUY U. S. WAR SAVINGS STAMPS AND BONDS

Don't live in "Igloo" again



KEEP WARM WITH BALSAM-WOOL ATTIC INSULATION



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Balsam-Wool, highest efficiency insulation, is guaranteed to give you complete satisfaction or your money back. It is tailor-made to your attic—easy to apply. Hundreds of thousands of pleased home owners can testify to the lasting comfort and fuel savings that go on year after year as a result of the outstanding performance of this product.

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Balsam-Wool

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The Mystery of Mars

(Continued from page 127)

iron of the planet as the result of oxidation.

There are some indications that the surface of Mars is fairly flat, with few mountain chains and little rugged country. Near the south pole there is some irregularity known as the Mountains of Mitchell. The polar cap, dwindling in size through the Martian summer, does not disappear uniformly. It breaks up into sections with rifts always appearing in the same place, season after season. Also, the melting is not symmetrical around the true pole. These so-called "mountains," whose existence is inferred from this peculiar behavior of the cap, may be only plateaus. The general smoothness of the Martian scenery probably is not the result of erosion. We prefer to believe that on this small planet, whose diameter is about one half that of the earth, mountain-building forces never came seriously into play.

One of the "keys" that appear to unlock these secrets of Mars is contained in Percival Lowell's original book on this subject. Lowell found that the mouth of each canal, at the edge of the ancient sea bed, is marked with a curious triangular dark spot. He thought that they might possibly be "relay stations for the water before it enters the canals." The shape of the markings, as reported by Lowell, is precisely that of the Greek capital "delta." And in that word perhaps we find the true clue to their nature. Back in the days when the seas were full of water and Mars was young, these deltas were formed by the natural process of erosion and deposit. We have many such formations on the surface of the earth, and if our oceans were to dry up we should find these deltas among the most fertile of all the areas on the earth's surface. The interpretation of these triangular markings as deltas was suggested to me many years ago by Burger, a Colorado amateur astronomer. Their appearance welds together a picture that would otherwise be very uncertain. The further interpretation of the canals as river valleys is also suggestive. The valleys are relatively wide and straight, whereas the path of the river in the valley may be winding.

The character of the Martian vegetation may only be conjectured. If our earth's oceans were to vanish, their beds would be left so poisonously salty that it is doubtful whether any sort of vegetation could exist. Perhaps the oceans of Mars disappeared before they had a chance to become very salty. But then, again, the very consider-

(Continued on page 208)



"My *Buddy* back home
is my Harley-Davidson"



That's what the men in the armed forces say about the Harley-Davidsons they left at home. And typical of what the boys who ride Harley-Davidson Motorcycles in the war think is this excerpt from a letter: "Out here Harley-Davidsons are the best a man could ride. They have the guts to get up and pull out of any sand hole within reason. We climb sand dunes sometimes as high as 40 or 50 feet without any trouble at all. They take all the punishment we can dish out — cross territory even tanks can't get over. One of our ranking officers said the other day, 'our motor jockeys would ride those Harley-Davidsons through hell and back and make their own road.'" Sounds like the good old endurance run, hill-climb, gypsy tour and race meet days, doesn't it? Those days will be back, and when they are, Harley-Davidson will have even better Motorcycles for you. Mail coupon today!

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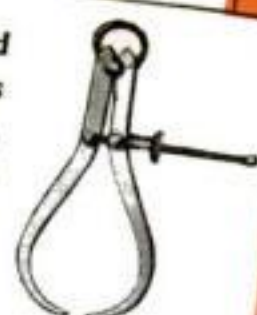
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DESIGNED to make accurate depth measurements of holes, slots, shoulders, and projections, the Millers Falls Depth Gauge is a rugged, precise shop tool. Spindle movement one inch, capacity 0 to 3" by .001"; capacity may be increased up to 12 inches with Millers Falls hardened and precision-ground extension rods. Several special features insure accuracy and long wear — standard Millers Falls extra quality.



TO MEET constant demand, Millers Falls micrometer production has been increased several hundred percent during this war. Typical Millers Falls quality, these are high-precision tools; now used largely in the manufacture and repair of war goods, they'll also be needed in huge quantities for production and maintenance in the mechanized world of tomorrow. Plan now to "tool up" with Millers Falls quality micrometers.



THERE ARE 64 kinds and sizes of Millers Falls calipers and dividers — 3 to 12 inches, inside, outside, and hermaphrodite. All are designed to meet the most exacting requirements of skilled machinists and tool-makers. Made of crucible steel, with rounded edges, hardened, ground, and polish. Many features for accuracy, rigidity, and convenience. Millers Falls' 75 years of tool-making "know-how" shows in these quality tools.



MILLERS FALLS TOOLS

SINCE 1868

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The Mystery of Mars

(Continued from page 206)

able deltas left by the rivers would indicate that fairly large quantities of mineral salts were washed into the seas. It is doubtful, therefore, that Mars can support more than the lowest forms of vegetation, mosses, lichens, and various types of rank sea growths that have become adapted by evolution to living out of water.

Many of Lowell's Martian drawings show that the dark areas are crossed by still darker "canals." The lines are continuations of the rivers, and many of them intersect at a dark round spot near the center of each ocean. Even these markings can be given an interpretation. For, as the seas dried up or sank into the planet, each river would have an extension away from the delta, seeking a lower and lower spot of the sea bed. Thus, the dark areas at the center of each bed are to be interpreted as drain sumps of the vanished, or vanishing, Martian seas.

With both water and air, the great stabilizers of terrestrial temperature, so scarce on Mars, the planet is subject to large differences in night-to-day temperature. Observations indicate that the surface temperature of the equatorial and the temperate zones rise above the melting point of water during the Martian daytime. But at night the entire planet must suffer subzero (F.) temperatures.

The polar cap is probably only a light deposit of hoarfrost, rather than a deep accumulation of snow and ice. And the melting of the polar cap during the Martian spring and summer is to be thought of as a defrosting process, not unlike that going on in an electric refrigerator when the current is turned off. The zone of the midnight sun, namely, the polar cap in midsummer, is probably the warmest area of the planet—a sort of Martian "Palm Beach."

As for the presence of animal or human life on the surface of Mars, it is apparent that only the lower forms could be able to exist under the extreme conditions of the Martian climate. I refer, of course, to "life as we know it." As for any other type of life than this, anyone else's imagination is quite as good as mine.

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Choice Grains \$5

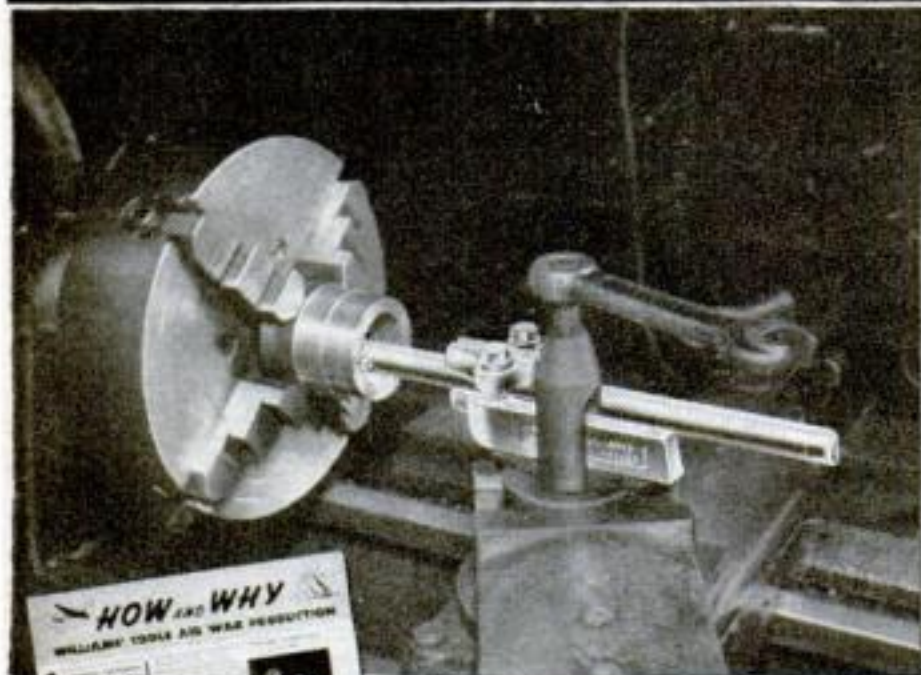
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HOW TO USE WILLIAMS' LATHE TOOLS FOR INTERNAL THREADING



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Once explained, internal threading with Williams' Tools is simple. Data Sheet No. 15 tells how. Other Data Sheets in the series are listed below. Circle the numbers of those desired on coupon and mail today. They're punched for 3-ring binder.

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WILLIAMS
SUPERIOR DROP-FORGED TOOLS

Road Maps of the Sea

(Continued from page 100)

imaginative youngster, recovering a corked and message-holding bottle from the surf, may anticipate finding a romantic message of shipwreck. But the slip of paper he reads is headed "BOTTLE PAPER. U. S. Hydrographic Office." Then follows the name of the officer who tossed the bottle overboard, his ship, the date, the latitude, and the longitude. In eight languages there follows a request to the finder to add his own name and address, plus the date and place where he picked up the bottle, and to return the slip to the Hydrographic Office or to the nearest American consul in his country.

Because ships do not care to reveal their positions in wartime, distribution of "bottle papers" has ceased for the duration. But returns are still coming in. Some of the bottles travel far and long. One bobbed about in the Pacific until it was more than 10,000 miles from its starting point—and this is not a record.

In one office, you meet an expert in the Japanese language. Surrounded by flower-ornamented dictionaries, he is diligently "translating" Japanese charts that may be of service to American warships.

Moonlight charts, showing the brightness of the moon at various times and locations, are another reminder of war. They indicate when darkness will cover a raid on enemy-held territories.

By the time that the United States entered the war, American pilots were well acquainted with "Approach and Landing Charts," newly developed by Hydro, which enabled flyers of average skill to make safe landings in totally unfamiliar and obscure places.

An improved star finder and identifier, developed by the Hydrographic Office, eases the task of aerial navigators, especially when clouds obscure a part of the night sky. This outfit includes a star map and a series of interchangeable scales, each corresponding to a certain latitude. When the proper scale is mounted on the map and set according to the observer's local meridian, the altitude and azimuth of any visible stars may be read from the scale markings.

As an indication of the variety of Hydro's publications, one of the most recent bears the title, "Eskimo Place Names and Aids to Conversation." Standard "Pilots," supplementing nautical charts, give detailed directions for reaching desired destinations, much after the fashion of automobile guide books—except that lighthouses and buoys replace road forks and railway bridges.

A GOOD NUT ALWAYS HOLDS

● When a nut slips it falls down on the only job it has to do.

When it shakes loose it fails in its sole purpose.

It takes a good nut to hold fast and stay put against stress and vibration.

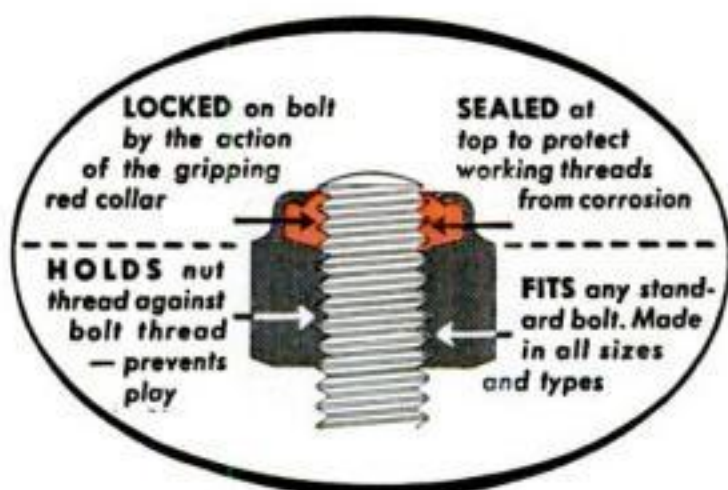
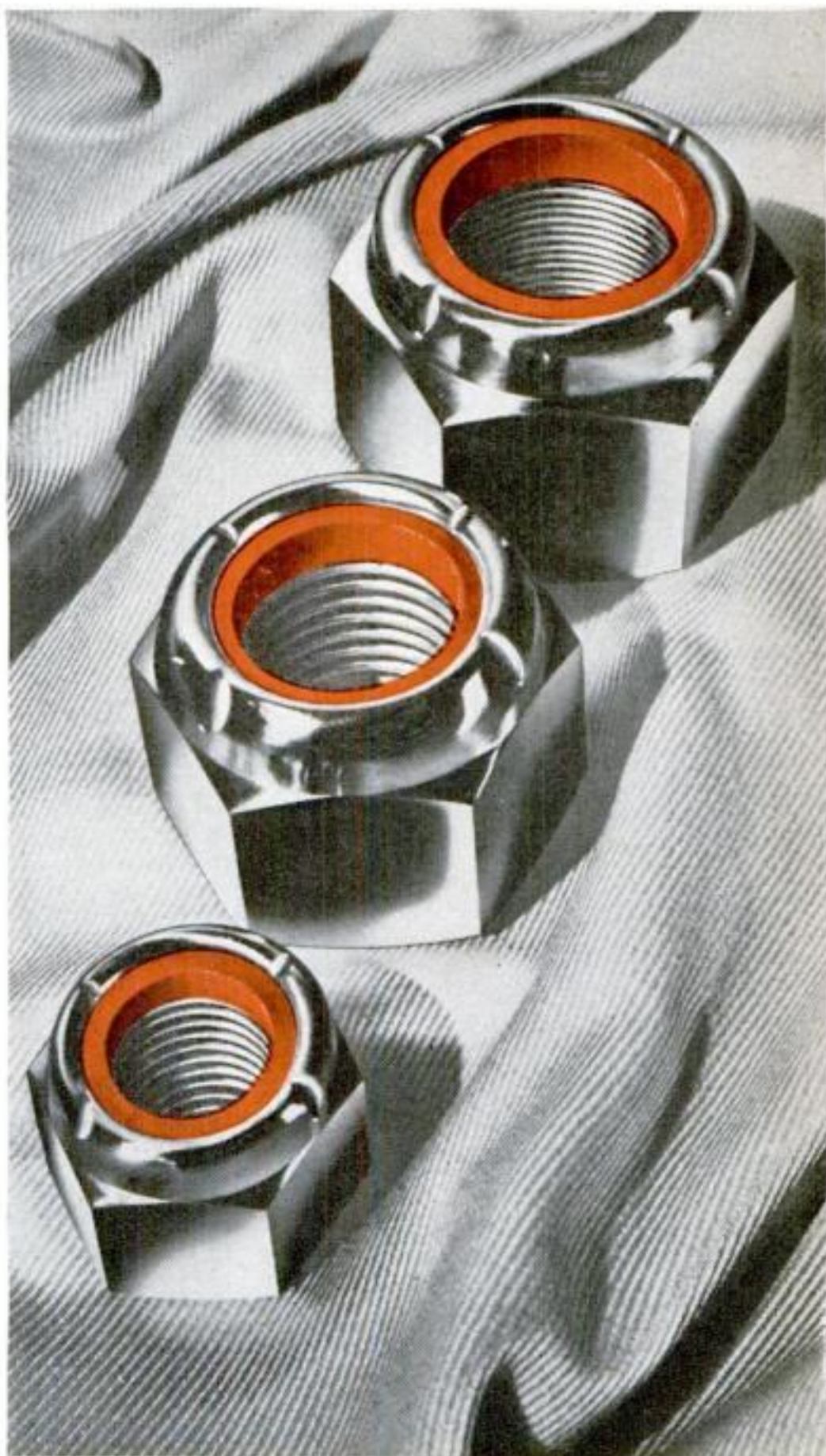
The Elastic Stop Nut does.

In its top is a red elastic collar. This collar molds itself tightly to the bolt. It keeps the nut and bolt threads in pressure contact. The nut can't wiggle or turn.

This is what makes the Elastic Stop Nut stay tight.

We've been making Elastic Stop Nuts for years. Millions of them every day go into war production. Some of our planes take as many as 50,000 in a single ship.

Yet of actual billions in use, we have never heard of one of these nuts that has failed to hold better than any other similar fastening.



ELASTIC STOP NUTS

Lock fast to make things last



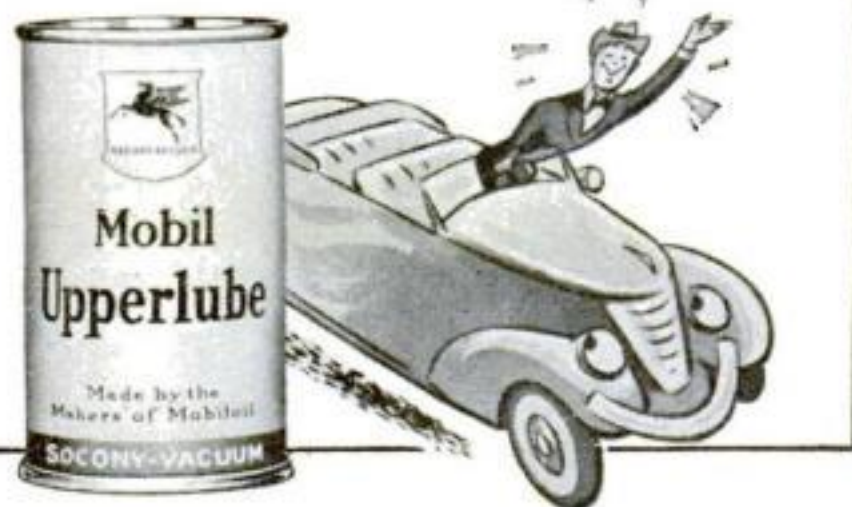
ELASTIC STOP NUT CORPORATION OF AMERICA
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Stop That Bucking!



DRIVE IN TODAY FOR A Tonic Treatment!



IF YOUR CAR is getting balky—bring it in for a *Mobil Upperlube Tonic Treatment*. Most Mobilgas Dealers are prepared to give this treatment. It should do these things for your car:

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OTHER MOBIL SPECIALTIES:

Mobilgloss • Mobilwax • Mobil Handy Oil
Mobil Radiator Flush • Mobil Stop-Leak • Mobil Window Spray
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BY SOCONY-VACUUM

Can We Fly at 50,000 Feet?

(Continued from page 64)

before, he made the leap—one of the highest on record—with no mishap beyond a frozen hand.

Now, scattered over the nation, in the plants of major aircraft companies, in colleges, or at military and Government research plants, are special wind tunnels, cold chambers, and low-pressure chambers which can synthesize high-level conditions so that we can explore the mysteries in comfort and safety.

One of the newest of these is the 600-m.p.h. wind tunnel now being built at the Army Air Forces' major experimental station at Wright Field. It is to be 600 feet long, shaped like an “O.” A 40,000-hp. electric-motor system will drive fans capable of whipping up a 600-m.p.h. controlled gale. The rapidly moving air will be sped through cooling coils in which are circulated tons of calcium chloride solution chilled to -40 degrees F.

To make stratosphere tests, models are placed in a steel compartment in the throat of the tunnel. An airtight door is sealed and the air is pumped out to simulate stratosphere conditions.

A pressure cabin in a stratosphere plane is like a deep-sea bathysphere, working in reverse. Its job is to keep the life-giving pressure inside. Unlike the bathysphere, it must be pierced in several places to allow control cables to pass through from the pilot's rudder and control column to the ailerons, rudder, and elevator. The problem has tentatively been solved by a system of glands. In some cases, the cable may have to pass in and out of the cabin several times. Each of these offers a new opportunity for the precious sealed air to escape. This problem is currently being investigated by Consolidated-Vultee in their high-altitude research department.

There still are a number of things we do not know about how metals will act under conditions of extreme cold. In metal monocoque structure, now widely used in aircraft, an important consideration is the yield point, or degree of stretching and bending that a particular metal will take and still return to its original size and shape. Efficient design calls for the use of materials whose yield point is close to their ultimate strength.

Windows and transparencies are necessary in high-altitude bombers, and they will be required in the transports of the future. How will transparent plastics act in the ex-

(Continued on page 214)



When the Sporting Arms Industry goes to War

Whenever war threatens . . . immediately the skill, experience and facilities of the makers of sporting arms become available to our Government as an important source for producing military equipment.

As in World War I, so today the industry is proving to be a vital factor in the production of enormous quantities of essential small arms.

We at "Savage" are making Browning Aircraft Machine Guns that have won commendation throughout the world for dependable and devastating fire power. And other guns and military rifles . . . in quantities that once seemed impossible.

Savage Arms Corporation, Utica, N.Y.

SAVAGE



Our Army-Navy "E" pennant bears the white star signifying 'continued determination and patriotism in war production'

When the war is won . . . you'll want this rifle

The pre-war pride of big-game hunters throughout the world . . . the "SAVAGE 99." A streamlined high power rifle with refinements in mechanism that assure unusually quick, positive and safe operation—a rifle with a consistent record of performance that is extraordinary.





Dear Joe: Still bronco busting!

Thought I'd left all that behind at the Lazy Y, but get a load of me in that snap.

That's an Indian Motorcycle I'm riding -- and believe me, it's a great machine. Easy and safe to handle, and it stands up under this cross country stuff like nobody's business. An Indian ought to last forever on a decent road!

I'm going to get me a personal Indian after this war and have some real fun. The old cycle fans in the outfit tell me it'll be the greatest Indian ever built. Write soon, eh?

INDIAN MOTORCYCLE COMPANY, SPRINGFIELD, MASS.



**BUY WAR BONDS NOW
★ ★ TO BUY AN INDIAN LATER ★ ★**

Can We Fly at 50,000 Feet?

(Continued from page 212)

treme cold, with pressure on the inside and virtually none without? Rohm and Haas, pioneers in plastic resins, have recently opened a plastics research laboratory at Bristol, Pa., to solve some of these problems. Part of the equipment is a supercold room where temperatures can be dropped below stratosphere level and engineers, working in electrically heated suits, can test plastics for impact and pressure under all temperatures.

Of course, the structure of stratosphere cabins themselves is subject to considerable test. It is essential that engineers know what is happening to the surface of the pressurized cabin as the ship climbs, and the difference in pressure inside and outside the cabin is manifested in a bulging effect. To determine this, Celstrain gauges, tiny assemblies of strain-sensitive wires, are fastened to points where the structure tends to be weak, such as around windows. The gauges, in giving the changes in resistance to electrical current in proportion to the strain exerted, tell the engineer how the structure is behaving at various pressures.

Windows, being made of a less highly stressed and flexible material, are an engineering weak spot. To determine how glass will act under sudden changes of temperature and pressure, specimens are mounted on pressure boxes and examined by polarized light. The underside of the glass is aluminized.

The more complicated the airplane becomes, the more equipment there is to be run electrically. This adds to the drain on the airplane's battery and generator system. Up to a certain point, the airplane's own generating system, driven by a spur from the main engines in the accepted automotive manner, was sufficient. With the arrival of pressurized cabins, electric cowl flaps, etc., the burst strain possible on the reserve was so great that it was possible to burn out the brushes in the generator in a few minutes. Average operational life at 30,000 feet was a couple of hours.

Westinghouse Research Laboratories recently offered a solution to this problem in the form of new chemically treated brushes composed of porous carbon impregnated with a lubricant which films between the brush and the swiftly rotating commutator. Their use allows a burst overload, eliminating, in many cases, the need for auxiliary generators.

One by one, the problems of the conquest of the stratosphere are being solved.

GREASE

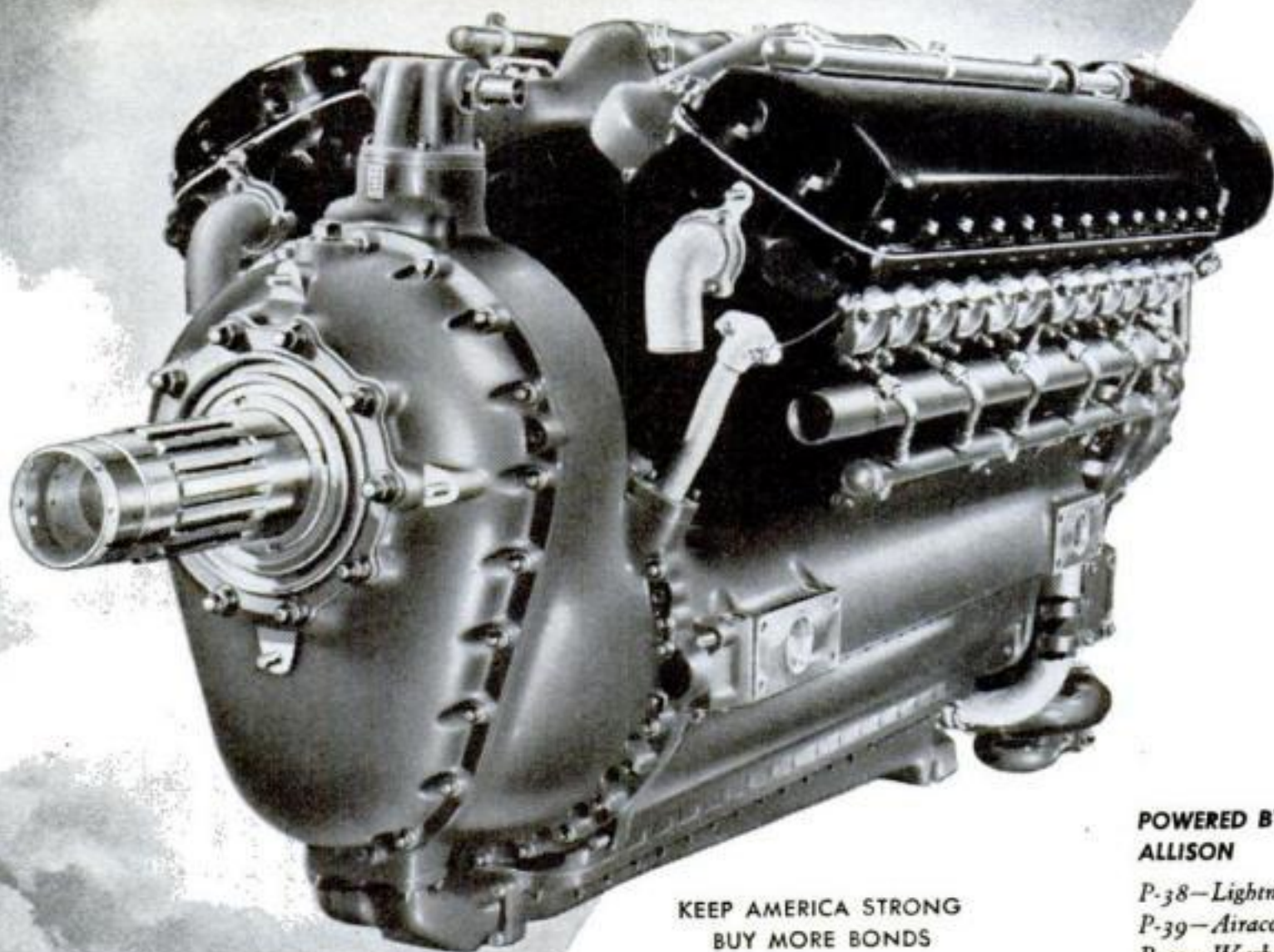
HOW MEN HATE GREASE!

Old-fashioned, greasy brushless shave is out! Men are switching by the thousands to the new, improved Mennen Brushless Shave because it has this big advantage — it's a cream, not a grease! Get it today at your druggist's in either jar or tube.



THE SKY IS NO LIMIT

There is only one way for any builder of an airplane engine to approach his job, and that is to make each part as fine as he is able to make it. ★ But in achieving this goal, Allison started with two special advantages. ★ One was the opportunity of drawing upon all General Motors' "know-how" in the perfection of manufacturing techniques. ★ The other was a privilege which had been ours for many years—the privilege of concentrating on assignments calling for high skill and precision in working with metals. ★ Perhaps we are aiming high, but with two such advantages it is natural our aspiration should be to seek to build ever finer aircraft engines.

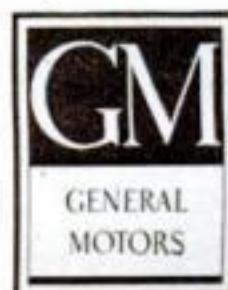


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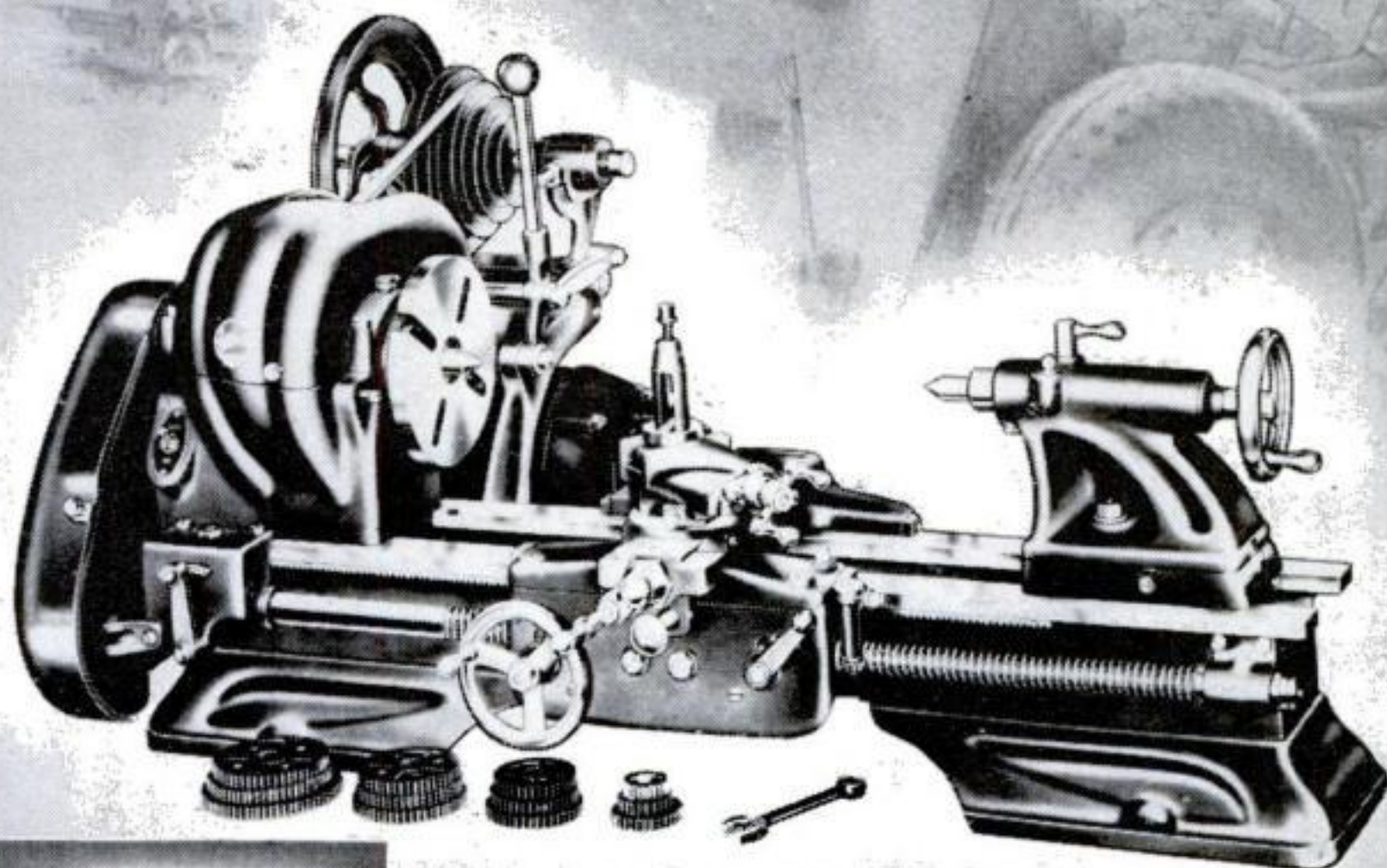
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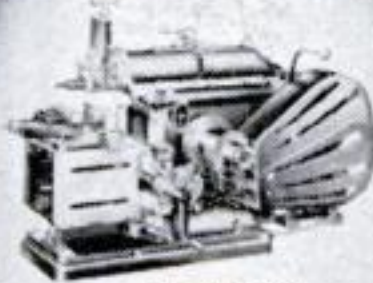
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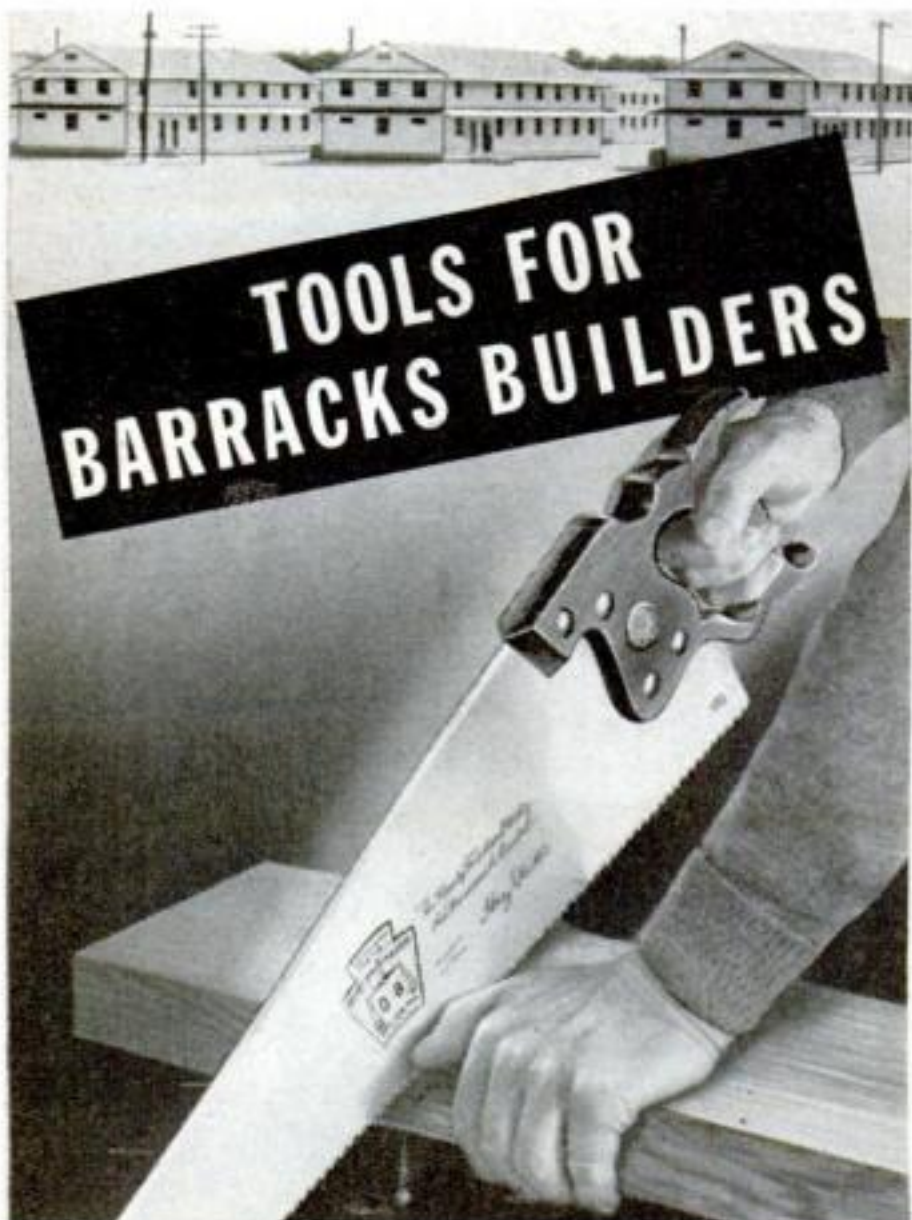
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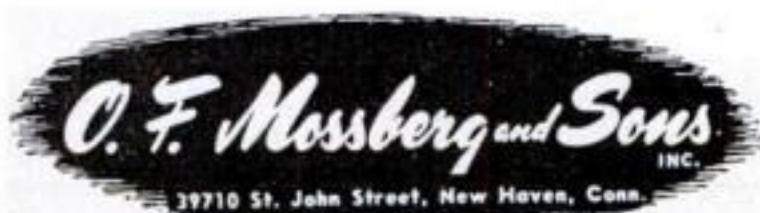
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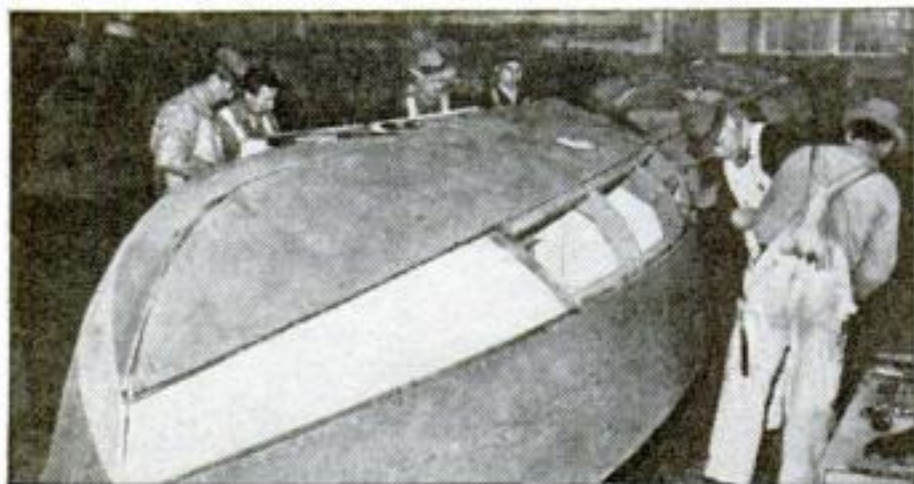
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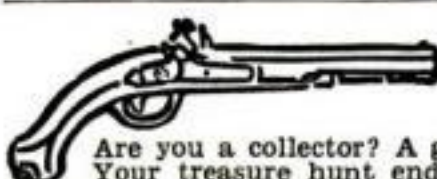


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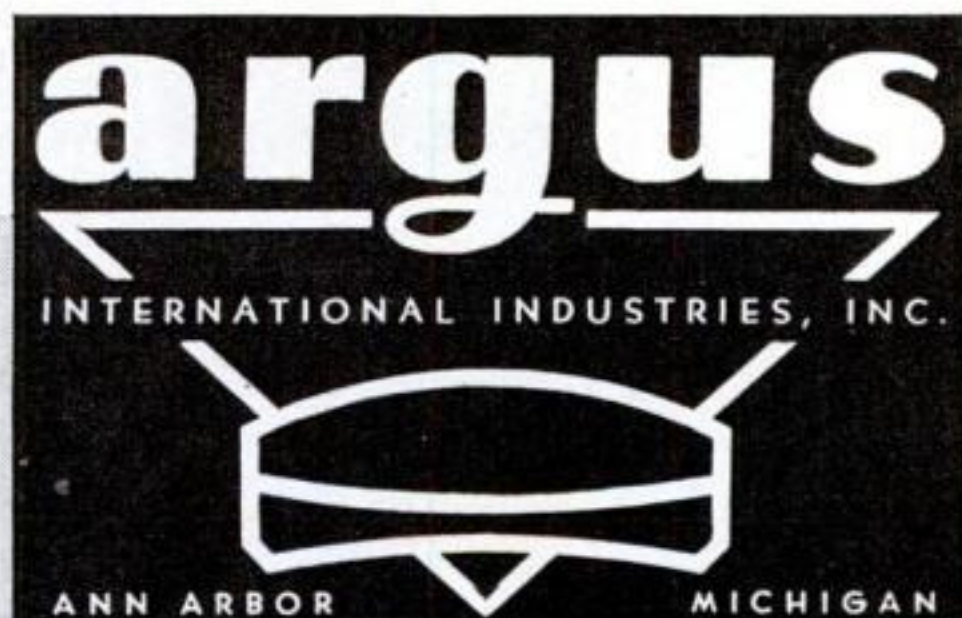
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Love to all,
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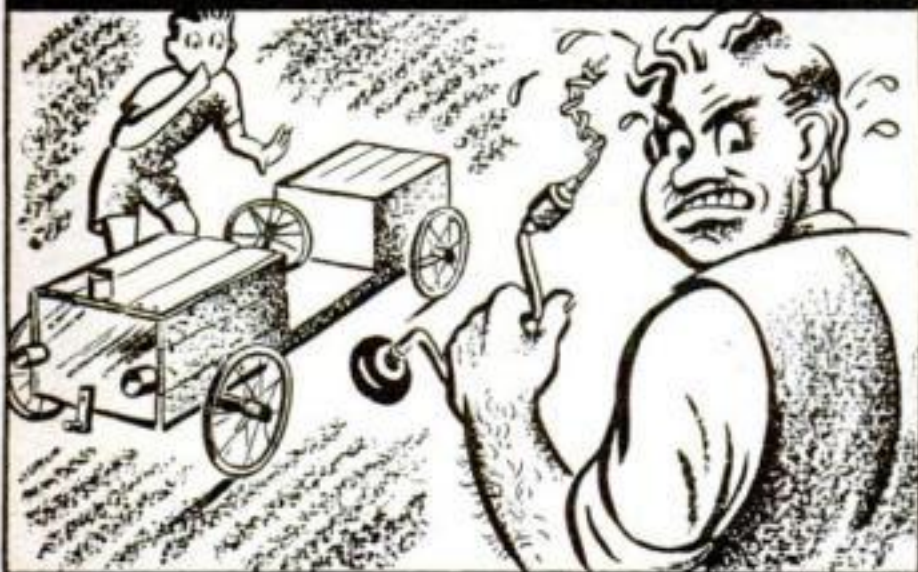
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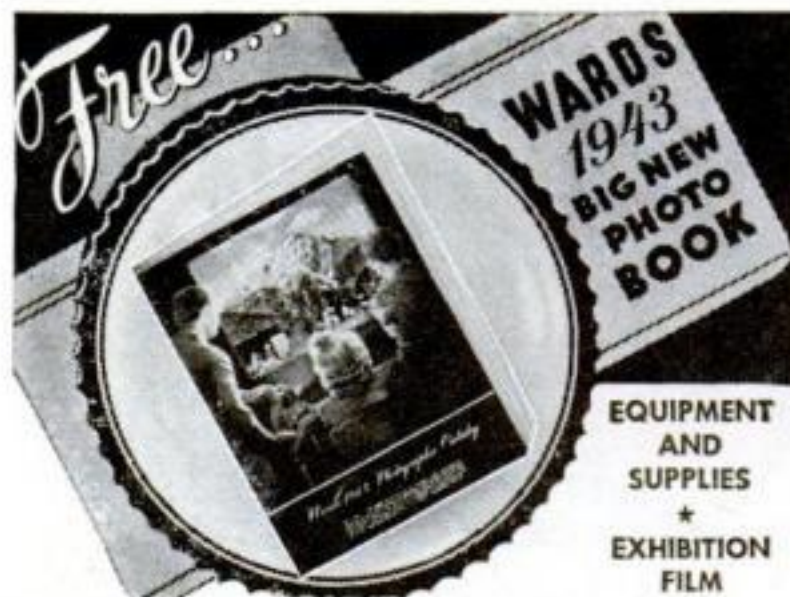
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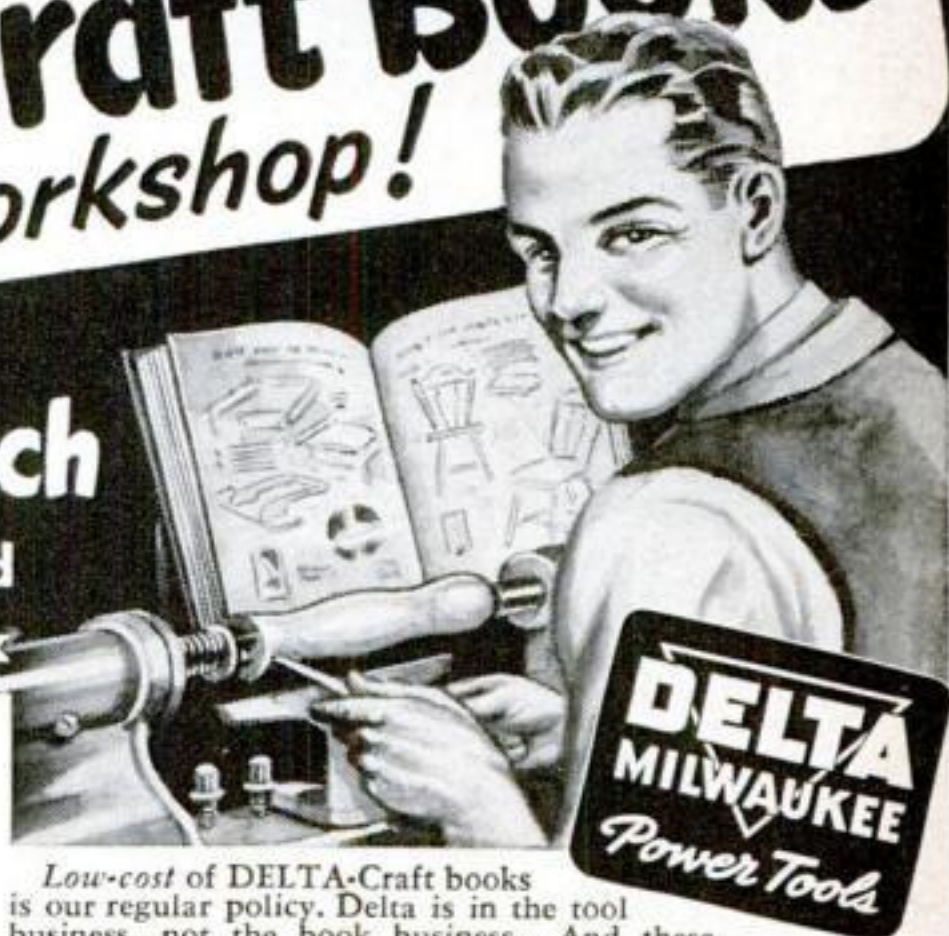
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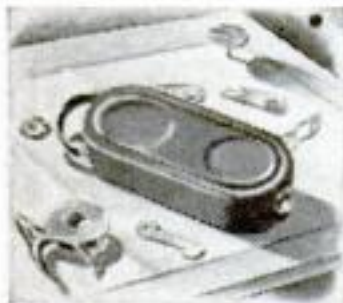
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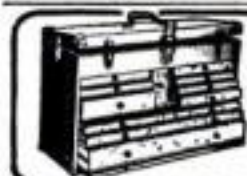
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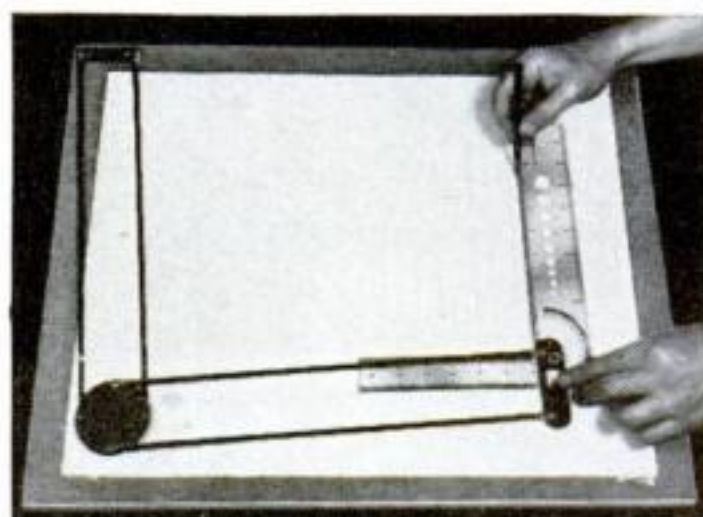
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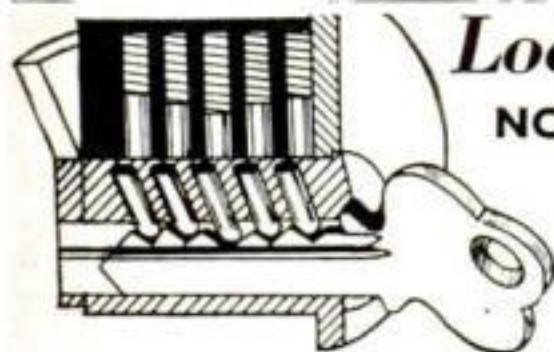
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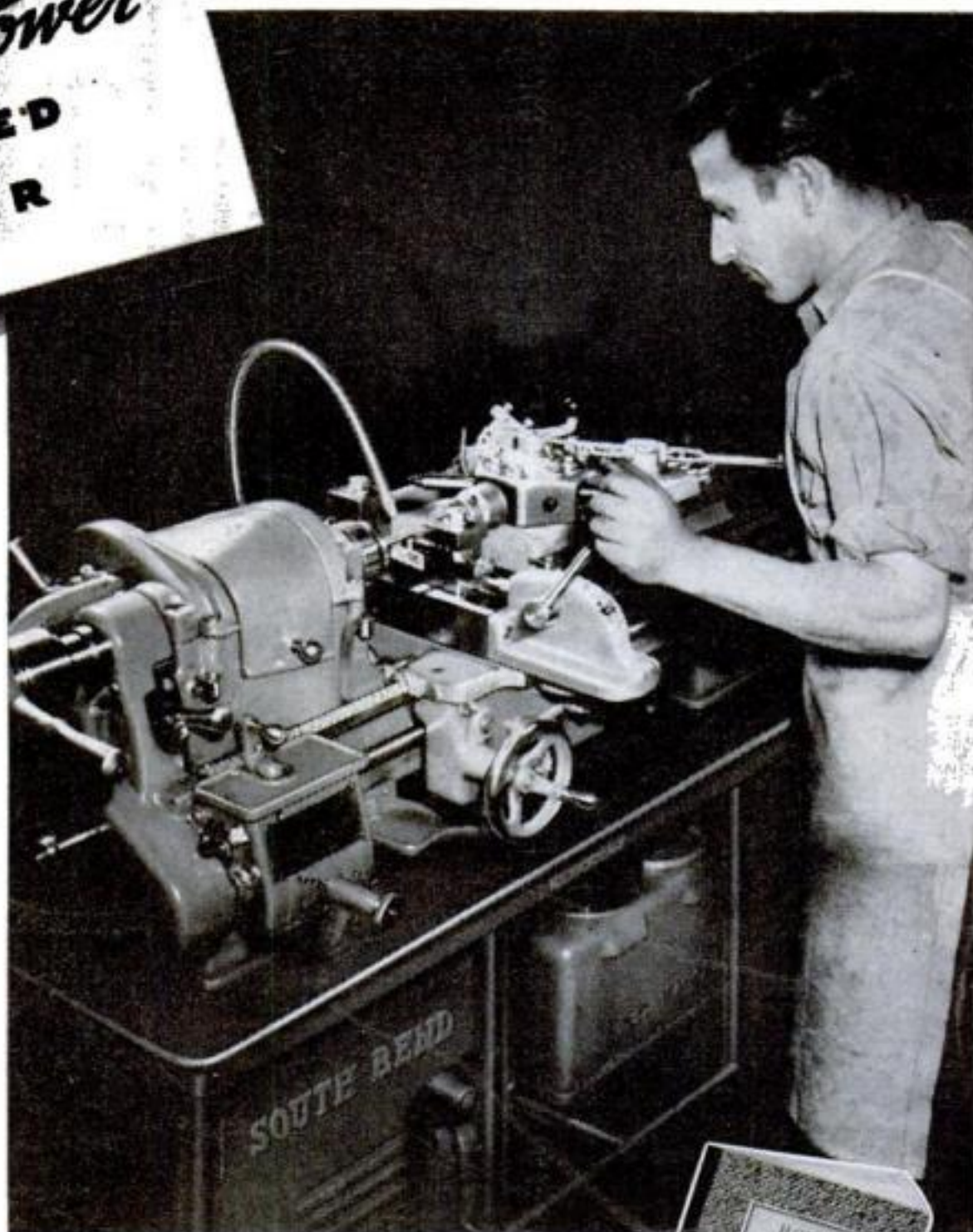
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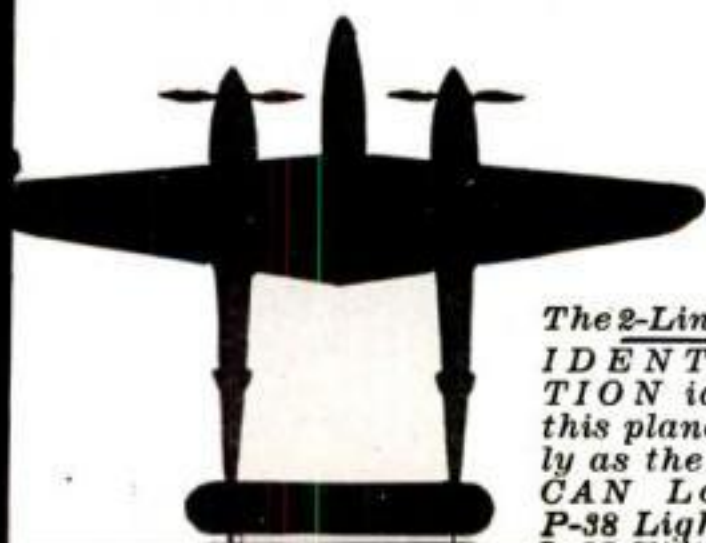
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